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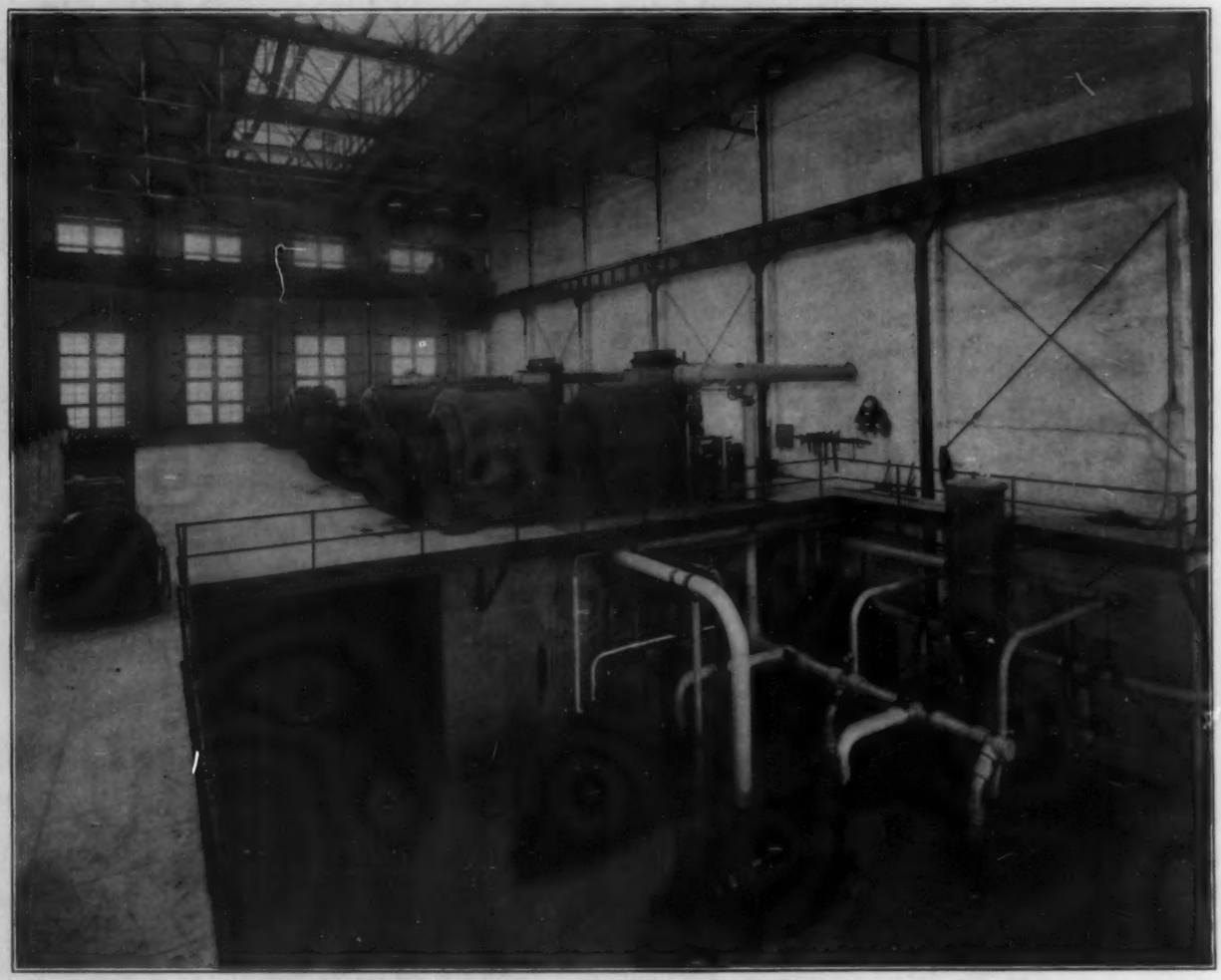
PACIFIC COAST EMERGENCY GENERATING STATIONS[1]

BY A. M. HUNT.

No matter what care and skill are exercised in designing and constructing a hydroelectric plant, with accompanying high-tension transmission lines, absolute continuity of service is a thing which cannot be assured. This is more particularly true of our Western plants as compared with those of the Eastern section of the country, and is especially true in California. Practically all of our important hydroelectric plants are located on streams which find their way down the western slope of the Sierra Nevada range of mountains through deep canyons. The sides of the canyons are usually very steep, and furnish very poor foothold for ditch construction. The cost of driving tunnels is usually prohibitive, and in the majority of cases, box flumes, built of lumber, are used to carry the water.



Steam Turbine Reserve at Oakland Station Great Western Power Co.

Our winter season is one of rains and heavy precipitation, and it is not infrequent that flumes go out, due to water-soaked foundations, slight leaks undermining footings, breaks caused by falling rocks, or other causes. This means an interruption of power service. Interruptions may and do come from line troubles due to many causes.

Interruptions of service were more than occasional in the earlier days of transmission work on the Coast,

[1]Paper presented at the San Francisco meeting of the American Institute of Electrical Engineers, May 7, 1910.

and even today with the better construction and design, and greater care and watchfulness in operation, they occur often enough to be matters for serious consideration.

The best means for avoiding the serious results from interruptions of service, is to reduce the period of time during which power is off the line. Any interruption of service is serious, but if a prospective power purchaser could be assured that his interruptions would be a minimum, and that when they did occur, they would be of very short duration, he would not be so apt to refuse to purchase power from the hydroelectric company on the score that the supply was not dependable. Such shortening of duration of interruption can best be accomplished by having at the receiving and distributing point an emergency generating station, maintained at all times in such a state of preparedness that it can be started and put on the line in the shortest possible time.

Under the conditions existing in California, it may become necessary to operate such a stand-by plant continuously for considerable periods, due to seasons of low water, and it is, therefore desirable that its economy should be good. In fact, I believe I may safely state that no stand-by plant has been installed on the Coast which has not become an important operating factor of the system with which it is connected.

I propose to discuss the type of stations for this service, making comparison between a station having generators driven by gas engines, and one in which steam-driven turbo-generators are used. I shall try to establish the thesis that the turbine station can be so designed as to be built at much less cost than the gas-engine station; that it can be kept in a state of preparedness where it can be put into service on the line as promptly as the gas engine station; that its stand-by charges will be less than for the gas-engine station; and that its economy, when called on for continuous operation, will be at least as good as that of the gas engine station.

Premises Assumed. The station shall have a capacity for continuous operation of 25,000 kw. at 85 per cent power factor.

Crude petroleum will be the fuel used both for generating steam and for gas making.

The station to be located at a point where spur-track facilities are available, and where ample water supply can be had.

In making comparison of economies with station in continuous operation, it is assumed that the load factor will be 50 per cent.

General Outline of Gas Engine Station.

The station will contain 12 units, each having a continuous load capacity of 2,085 kw. at 85 per cent power-factor. The size of unit is small for a station having such a large capacity, but it is extremely doubtful if any of the engine builders will agree to build and guarantee larger engines, especially for use with gas made from oil. The experience with the large gas engines in the Martin station of the Pacific Gas and Electric Company indicates that the safe limit was passed there.

The following quotations from recent letters received from one of the large gas-engine builders is also confirmatory:

From reports made by various members of our engineering department, who have noted the large continental engines in operation, we gather that while some very large cylinders are still operating in the single-acting type, the European, and particularly the German companies, who have built larger than 42 in. or 44 in. diameter, using cast iron as the material, have been compelled to replace practically all of their cylinders, leads us to believe that they should not be attempted at all in cast iron, and if steel is used with cast-iron bush, the cost per brake hp. will be much larger than a smaller-sized unit, without any gain in efficiency or lessening of operating expense.

If economy is the controlling factor, it would seem to us that a size such as our 37½ in. x 48 in. (3,100 brake hp.), which can be made safely, with cast-iron cylinders would be a better proposition than a larger engine with longer stroke and larger diameter of cylinders which it would be necessary, or desirable, at least, to make of cast steel. We can readily understand how large power houses want turbine units of very large capacity of 10,000 kw. or more, as the economy of the turbine unit increases perceptibly as the sizes grow larger, and these very large units can show economies which are difficult to reach with the smaller sizes, but with the gas engines, if there is any difference at all, the reverse is the more likely to be true, as cylinders of moderate size can be effectively cooled and used with water of ordinary temperatures, while with the very large cylinders, in order to keep certain spots from getting hot enough to ignite the gas, other parts of the cylinders have to be kept unnecessarily cold. The desirability of good parallel operation also tends to cause a choice of smaller cylinder diameters, as with very large engines the slow speed and great number of poles cause the generator builder's requirements for operation to be very close indeed, and the weight of the flywheels becomes prohibitive, both from the point of cost and from the ability of the bearings to stand the load without heating.

The gas required per 24 hours will be 7,500,000 cubic ft., based on 650 B.t.u. per cubic ft., 50 per cent load factor, and assuming that by reason of the relatively small size of units, the engines will always be operated at approximately full load.

The gas-generating plant will consist of three oil gas sets, each capable of producing 2,500,000 ft. of gas per day, with necessary condensers, scrubbers, and purifiers, and a holder capacity of 2,250,000 cu. ft. to equalize the daily load. It is assumed that the units will have twin tandem engines, and the over-all size of foundation for one unit will be 70 ft. by 30 ft. Allowing for passages, the size of electric generating station will be 76 ft. by 400 ft. if engines are placed in one continuous line, or 152 ft. by 200 ft. if placed in two parallel lines. The station will have the usual compressed-air starting equipment.

General Outline of Turbo-Generator Station.

This station will be assumed to contain two turbine units, each having a continuous capacity of 12,500 kw. at 85 per cent power-factor. Each unit will have its condensing equipment, and the boiler plant will contain water-tube boilers in units of the largest size available. The boiler settings to be built so as to lose as little heat as possible by radiation from exposed surfaces. All boilers to have tight fitting dampers, which may all be opened from a central point. The oil and steam supply for burners to be controlled from the same central point, and so arranged that burners may be operated from such point. It is also figured that igniters will be fitted in the furnaces which can be

operated from the central point, so that fires can be started under all boilers simultaneously.

The boiler capacity in the station is assumed to be such, that maximum load can be carried by forcing boilers 33 1-3 per cent beyond builder's rating. This is easily done with oil fuel. Neither economizers nor superheaters will be used.

In connection with the plant will be installed heat storage, consisting of vertical steel cylinders containing water under a temperature due to 200 lb. steam pressure, thoroughly protected with heat-insulating material. The water and steam spaces of these cylinders will be connected with the boilers through automatic stop valves which will open whenever the pressure in the boilers is greater than in the heat storage cylinders. In the heat storage cylinders will be installed internal electric heaters having capacity sufficient to maintain the temperature of the water in them, or, in other words, to supply the heat losses from radiation and convection. The capacity of these heat-storage cylinders to be such, that by reduction of the gauge pressure from 200 to 25 pounds, sufficient steam will be formed to operate the plant at full capacity for thirty minutes. All steam connections to be as short and direct as possible, and all precautions used to keep radiation and condensation losses at a minimum.

On the above assumptions, the following calculations are based:

Rated Horse Power of Boilers Required. The turbines will require at 12,500 kw. load with 175 lb. steam pressure, 28 in. vacuum, and without superheat, 16.69 lb. of steam per kw. hr. To handle auxiliaries of the plant and the oil burners will require 10 per cent of that required for the main units, or the total maximum amount of steam per hour required will be 459,000 lbs. This can be furnished by 11,475 rated h.p. of boilers, working at 33 1-3 per cent overload. It is assumed that this boiler power will be installed in 16 units of 720 rated h.p. each.

The amount of heat storage required in connection with each of the above boiler units is calculated as follows:

When the pressure on water under a temperature due to 200 lb. steam pressure is reduced to 25 lb. about 13 per cent of the water will pass into steam at gradually reducing pressure. The assumption was made that the heat storage shall be capable of furnishing steam for the plant for 30 minutes at full load, or 229,500 lb. This is increased by 33 1-3 per cent to allow for reduced economy of the turbines with the falling pressure, which calls for 229,500 plus 76,500, or 306,000 lb. As 13 per cent of the water in the storage cylinders passes into steam, they must contain 306,000 divided by 0.13, or 2,353,847 lb. Each of the 16 boiler units will, therefore, need 147,116 lb. of hot water in storage. Assuming the water to weigh 60 lb. per cubic foot at temperature due to 200 lb., the volume of the containers will be about 2800 cu. ft. This volume will be provided by one cylinder, 12 ft. in diameter by 26 ft. in length, allowing steam space over the water. Each of these cylinders will weigh approximately 120,000 lb., and will cost delivered and in place not to exceed 6½ cents per lb., or $7,800. Each storage cylinder will supply 1563 kw. of station capacity, or the cost of storage per kw. capacity of plant will be about $5.00. These figures are given to show that the cost is not prohibitive.

Comparisons.

Comparison of First Costs. The cost of the gas-making station, as above outlined, is assumed as being $1,000,000, complete with buildings and storage. The figure is based on data procured within the past two years, and if in error, is possibly too low.

The cost of the electric generating station complete, including gas engines, generators, piping, switchboards, wiring, foundations and buildings will be approximately $2,250,000, based on recent quotations.

At these figures, the cost per kw. capacity of station for combined gas and electric plant will be $130 per kw.

The cost of the steam-turbine plant complete, including turbo-generators, boilers, heat-storage cylinders, piping, condensers, switchboard, wiring, foundations and building will not exceed $1,500,000, based on recent quotations. The cost per kw. capacity of station is, therefore, $60.

The steam-turbine station cost is approximately 46 per cent of that of the gas-engine station.

Comparison as to Rapidity of Getting into Operation on the Line. It has been demonstrated in the Martin gas-engine station, previously referred to, that one of the large engines can be brought up to speed, its generator synchronized, and connected to the line in 30 seconds. In order that this may be done, however, the operator must be at his station when the signal is given. In the station assumed, 12 engine operators would be required, each at his post, all equally trained to accomplish this, and probably an equal number of switchboard operators. Even then, difficulties in synchronizing such a number of machines simultaneously would probably take a longer time. The expense of keeping such a large operating force as this calls for is too great to be feasible, and I assume that each operator will handle two engines, and that he will get the two generators on the line in two minutes. I should consider it exceptional work if the entire station could be in operation on the line in two minutes.

In the case of the steam-turbine plant, the following sequence of operations would be followed: The turbo-generators would be operating on the line as synchronous motors to assist in regulating power factor, and with vacuum maintained on the steam ends, with the air pump operating. Steam would be in the main line up to the throttle valves, also on oil-burner line. If current on the line fails, the rotors of the units will continue to revolve for many minutes. Immediately on notice, the operator will begin opening his throttle valves, and energizing his fields from a storage battery, and could easily synchronize the two machines and get on the line within less than two minutes. The air pump, if operated during the period of starting from the storage battery, would require no attention, and if a jet condenser is used, the only requirement in connection with circulating water is that the injection valve shall be opened.

Concurrently with the above, the boiler-room

operator will release and open all boiler dampers at one operation, and from the same central point, put steam and oil on all burners and by the use of electric igniters start fires under all boilers simultaneously. The steam pressure in the heat-storage cylinders will gradually fall until at the end of 30 minutes it will have reached 25 lb. By the expiration of that time, the boilers can be brought to steaming condition under a pressure of 25 lb. or more, and will pick up the load.

I consider that I have reasonably established the fact that the steam-turbine station can be put on the line as promptly as the gas-engine station.

Comparison as to Stand-by Charges. I shall consider this on the basis of the annual stand-by charge per kw. of capacity of plant.

Assuming that the fixed charges of interest, depreciation and taxes will amount to 10 per cent which favors the gas-engine plant, the annual charge against the gas-engine plant will be $13 per kw. and $6 against the steam-turbine plant.

I will assume that the gas-engine station proper can be taken care of by two crews of six men each at the engines, and two at the switchboard, which is certainly more than fair to it. These men will get not less than $100 per month, or an annual pay roll for station of $19,200.

The gas making plant will also require two crews, each assumed to require six men, which number is an absolute minimum. Their average wages will be not less than $100 per month, or an annual payroll of $14,400. The combined payrolls will be $33,600, or an annual charge of $1.34 per kw. of capacity.

To keep the gas-generating plant in condition such that it can begin making gas with a reasonable degree of promptness, the generators must be kept fairly hot, which will require expenditure of fuel. I have no data of my own as to the fuel necessary for this purpose. Mr. E. C. Jones, chief engineer of the Pacific Gas and Electric Co. informs me that with an expenditure of 150 gal. of oil per day, it is possible to keep a 2,500,000 cubic-foot oil-gas set, at a temperature such that it can be brought to condition for commencing to make gas in 20 minutes. Three such sets will, therefore, take 450 gal. per day. The annual stand-by fuel charge, oil being figured at $1.00 per barrel, will amount to $3,911, or 16 cents per kw. of capacity.

It is assumed that the steam-turbine station will require two crews, each composed of the following: two turbine operators, one switchboard man and two firemen. The average monthly wage is taken at $100 per month, which would make the annual pay roll $12,000, or 48 cents per kw. of capacity. The heat-storage cylinders will be covered with extra thick heat insulating covering, around which will be built an enclosing shell of brickwork. It is assumed that the heat losses per square foot of shell, per Fahr. degree difference of temperature per hour, will not exceed 0.1 B.t.u. The total surface of all heat storage proposed is 37,728 sq. ft. With a temperature of external air of 70 degrees Fahr., the heat loss per hour will be 689,790 B.t.u. The main steam piping that will be under steam will have a surface area of not to exceed 3,500 sq. ft. The loss from this surface is taken as 0.2 B.t.u. per degree difference of temperature per hour, or a total loss on account of such surface of 221,900 B.t.u. The combined loss of 911,690 B.t.u. is equivalent to 359 h.p.-hr., or 270 kw.-hr.

In other words, it will only be necessary to use a little over 1 per cent of the capacity of the plant to keep the heat storage and main steam pipes up to temperature, as the electric heaters will transform the energy at practically 100 per cent efficiency. I think I may safely state that any of our hydroelectric plants have for at least 22 hr. per day energy going to waste in an amount much greater than 1.1 per cent of the peak load, and that under such circumstances the waste energy should not be considered a charge against the plant. The radiation losses, as above taken, would in two hours reduce the temperature of the water in storage less than 1 degree Fahr., so if no waste energy were available for two hours daily, the effect so far as the value of the heat storage is concerned would be negligible. The original heating of the water, and restoration of temperature of the water in the storage cylinders after a run would be accomplished by the use of steam from the main boilers.

It is assumed that steam will be kept on one 300-h.p. boiler, to operate pumps, to supply steam to burner lines and as an emergency precaution. An allowance of 450 gal. per day will maintain pressure on this boiler, and permit the use of 1000 lb. of steam per hour, and at $1.00 per barrel will amount to a yearly charge of $3,911, or 16 cents per kilowatt of capacity.

The stand-by charges per kilowatt capacity of the two plants will be as follows:

	Gas engines	Turbines
Fixed charges	$13.00	$6.00
Pay rolls	1.34	0.48
Fuel used	0.16	0.16
Total stand-by charges	$14.50	$6.64

The stand-by charges for the turbine plant are less than 46 per cent of those for the gas-engine plant.

It would be entirely legitimate to make a small charge against the gas-making plant for maintaining steam on one of its boilers, but this has been neglected in the above.

If the entire loss of heat from storage cylinders and piping were made good from the auxiliary boiler, the annual fuel charge for this service would not exceed $2,000.

I believe the above discussion proves my statement that the stand-by losses of the turbine station will be less than for the gas-engine station.

Comparison as to Costs of Continuous Operation. If I have been correctly informed, the manufacturers of the large gas engines at the Martin station, previously referred to, guaranteed them to deliver a brake horsepower-hour on 18 cu. ft. of oil gas. No data as to the results actually obtained have ever been given out, but from such information as I have been able to get, I do not believe that the results are any better than those indicated above.

From a paper read before the Detroit meeting of the American Gas Institute by Mr. E. C. Jones, chief engineer of the Pacific Gas & Electric Co., in October, 1909, I take the following data:

There will be required 8 1-3 gal. of crude oil to produce 1000 cu. ft. of gas, and from the process of

lampblack per 1000 ft. of gas made, which should be credited to the gas-making process. A portion of the lampblack will be required for generating steam used in the manufacturing process. It is impossible by any method of treatment so far found economically practicable, to reduce the moisture content much below 25 per cent and it is generally fired when containing at least this much moisture. I assume that at least five of the 20 lb. will be used for generating steam, leaving 15 lb. to be credited.

There is no way in which this lampblack can be used in the plant outlined herein for gas-making, although water gas apparatus could be installed to utilize it. Mr. Jones, in the article previously cited, states that using the lampblack in water gas apparatus, 40 lb. wet lampblack (30 lb. dry) will make 1000 cu. ft., using 6.8 gal. of oil for enriching. As 8 1-3 gal. of oil are used for 1000 cu. ft. of gas under the straight oil gas process, each 30 lb. of lampblack saves 1.53 gal. of oil, or for the 15 lb. excess produced in making 1000 ft. of oil gas, 0.77 gal. In order to give the gas-making process every credit it can be entitled to, I deduct this 0.77 gal. from the 8 1-3 gal., leaving 7.56 gal. net, chargeable to each 1000 cu. ft. of gas made.

If the generator efficiency is 95 per cent, and 18 cu. ft. of gas are used per brake horsepower, the amount used per kilowatt hour will be 25.24 cu. ft. The number of kilowatt hours per barrel of oil, from the data above, is 220.1.

To arrive at the kilowatt hours at the switchboard per barrel of oil in the steam-turbine plant, the following assumptions are made: That the average load-factor on the turbines will be 75 per cent when in operation; that the auxiliaries of the plant will require 10 per cent of the steam taken by the main units; that the evaporation of water will be at the rate of 12 lb. per lb. of oil.

The turbine assumed, is one where the steam consumption at three-fourths load will be no greater than at full load, or 16.69 lb. per kilowatt hour. Adding 10 per cent for auxiliaries gives 18.36 lb. of steam required per kilowatt hour, or at the evaporation assumed, 1.53 lb. of oil. The oil weighs 336 lb. per bbl., and the number of kilowatt hours per bbl. of oil will be 219.6 as against 220.1 for the gas engine. Attendance and fixed charges have been previously shown to be less in the case of the steam plant, so I consider that I have established the remaining statement as to economy made in the earlier part of this paper.

I have endeavored in the argument made to use data and assumptions that in all cases favor the gas-engine station, and feel that on this score I have opened the door to criticism by proponents of steam plants for this class of service.

In closing, I cannot refrain from calling attention to the desirability of fuller information relative to the gas-engine station at Martin, which I have previously cited. Judging from current reports it does not seem to have been an entire success. It is said that it is still in the contractor's hands, five years after installation, and that the purchasing company has abandoned it so far as use is concerned. Nothing has ever been published regarding its difficulties and troubles nor as to its economic results, and I hope that in the discussion of this paper those who know the facts will give the engineering profession the benefit of them.

FEED WATER HEATING AND PURIFICATION.[1]

BY G. N. SUMERVILLE.

A discussion of the subject of heating and purification of feed water might be carried on almost indefinitely, but the object of this is to bring before the operating engineers an outline of results obtained from the Cochrane heaters, manufactured by the Harrison Safety Boiler Works.

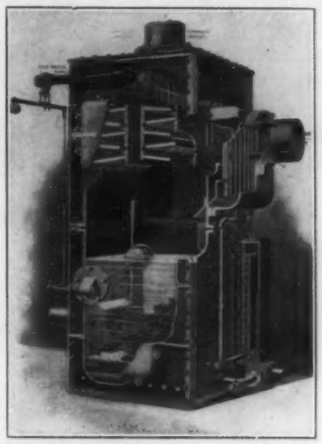
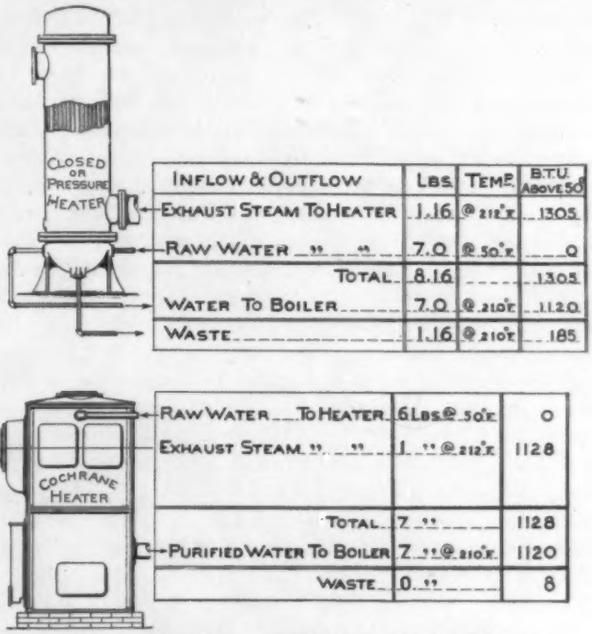


Fig. 1. Heater and Purifier.

In the first place, consider the heat transmission. In the Cochrane heater, Fig. 1, the heating of water is direct and instantaneous, because the steam comes in direct contact with the water. The steam is condensed at once and becomes pure, distilled water, amounting to from 1/10 to 1/6 of the whole boiler



INFLOW & OUTFLOW	LBS.	TEMP.	B.T.U. ABOVE 50°
EXHAUST STEAM TO HEATER	1.16	@ 212°F.	1305
RAW WATER " "	7.0	@ 50°F.	0
TOTAL	8.16		1305
WATER TO BOILER	7.0	@ 210°F.	1120
WASTE	1.16	@ 210°F.	185

RAW WATER TO HEATER	6 LBS.	@ 50°F.	0
EXHAUST STEAM " "	1 "	@ 212°F.	1128
TOTAL	7 "		1128
PURIFIED WATER TO BOILER	7 "	@ 210°F.	1120
WASTE	0 "		8

Fig. 2. Comparison of Open and Closed Heater.

supply. The feed water is heated to the full temperature due to the steam, and there can be no falling off in efficiency or capacity, no matter how long the heater has been in use or how full of scale and dirt it becomes.

On the other hand, note what happens in the closed heater: A coating of scale and mud from the water collects on one side of the heating surface and

[1]Paper read before California No. 3, N. A. S. E., Apr. 20, 1910.

oil and grease from the steam on the other side; both coatings hinder the passage of heat; and it is not uncommon to find closed heaters giving a feed water temperature of only 160 or 180 degrees F., although there is a surplus of exhaust steam and although a temperature of over 200 degrees could be obtained if the heaters were clean.

The closed heater, therefore, loses in efficiency from two causes. First, by throwing away the hot condensed exhaust steam and, second, by the fouling of the heating surfaces. From the first cause its efficiency is necessarily from 10 to 16 per cent lower than the efficiency of the other type, no matter how clean the closed heater is kept, and from the second cause the efficiency may be lowered still more, even so that the fuel water reserves only 50 per cent as much heat as it should from the exhaust steam available.

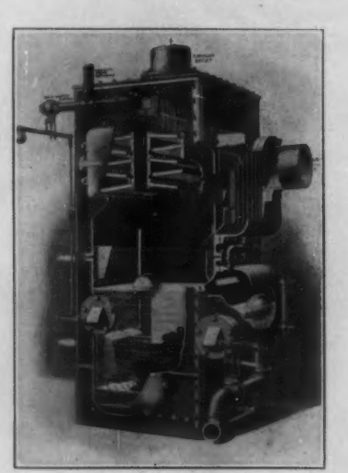


Fig. 3. Heater and Receiver.

Where the quantity of exhaust steam available is limited—i.e., where it is not sufficient to heat the water to over 200 degrees F., as in most condensing plants—the feed water can be made at least 10 to 20 degrees hotter by means of a Cochrane heater than with a closed heater. Each 10 per cent gained is 1 per cent of coal saved. At the same time the closed heater wastes enough pure water to represent one-tenth to one-sixth of the whole boiler supply. All water is consumed by the Cochrane heater.

In order to use the water over again as a feed water it is necessary that the steam be freed from oil before it is condensed. This is provided for in the Cochrane heater by a separator which is attached to and made part of the heater. (See Fig. 1.) The drain from this separator as well as the overflow from the heater are passed through a water seal to the waste pipe or sewer.

A hot well or return tank is provided for the storage of live steam drips, condensed returns and other hot water about a plant suitable for boiler feeding. The cold make-up water is automatically regulated by a ventilated copper float which controls the supply through a balanced valve in the supply pipe.

As a feed water purifier the Cochrane heater also does valuable work. The most common scale-forming elements found in boiler feed waters are lime and magnesia; which exist as carbonates and sulphates, the carbonates precipitating at about 200 degrees F., forming a soft, granular scale, while the sulphates are precipitated at about 290 degrees F. and form a hard, crystalline scale.

As the water is heated to 212 degrees in this heater you can readily see that a partial purification is accomplished in the heater by throwing down all the soft scale-forming elements which will precipitate at less than 212 degrees F.

Heater and Receiver.

After the exhaust steam has been used to heat the feed water there still remains present about 80 per cent of the heat in the steam as it left the boilers. It is desirable, if possible, to use this waste steam for heating building or manufacturing purposes. The Cochrane is especially designed for use in connection with any kind of exhaust steam heating or drying system,

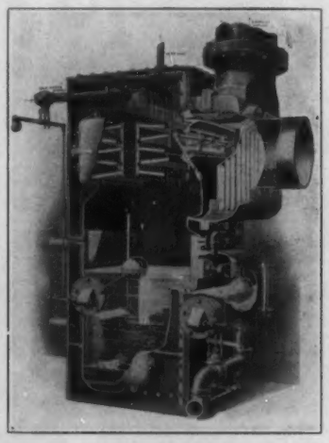


Fig. 4. Cut-Out Valve Heater.

the shell being adapted for carrying any working pressure up to 10 lb. per sq. in. These heaters are further provided with the equivalent of a steam trap, allowing the overflow and drips from the oil separator to pass to waste without permitting steam to escape or air to enter. The returns from the heating system are brought into the heater through a water sealed opening to prevent steam backing up into the return line and so arranged that the returns are broken up and heated by contact with the exhaust steam.

The discharge from vacuum pumps is generally delivered into the top of the heater and passed down over the trap, since it is usually considerably reduced in temperature by the injection of cold water into the vacuum pump. The float controlling the cold water inlet valve is set to close the latter considerably below the overflow level, so that storage is provided for the returns from the heating system.

The best way of installing a Cochrane heater and receiver in connection with a steam heating or drying system depends upon the local circumstances. When the volume of steam is not large it all may be passed through the heater, but where the amount of steam exceeds our stated rating for the separator, the heater is arranged, "to draw," the supply. There are several ways of piping the heater for this purpose, the most simple being to connect the exhaust main to the heater with a branch to the atmosphere, in which is placed a

back pressure valve, while a gate valve is placed between the exhaust to the atmosphere and the heater. The first steam that enters the heater will be condensed by the water flowing over the trap and more steam will follow as fast as it is needed. As a certain amount of air and gas will collect in the heater, a proper vent pipe to atmosphere must be provided. Another arrangement is to pass part of the steam through the heater and by-pass the remainder around the heater through an oil separator. If the exhaust should not be sufficient at certain times, a reducing valve can be so arranged that live steam can be admitted automatically to the heating system as required. Or, better yet, advantage may be taken of open heaters by means of which from $50 to $500 may be saved in the cost of piping, valves, connection, independent separator, trap and other fittings wherever there is a

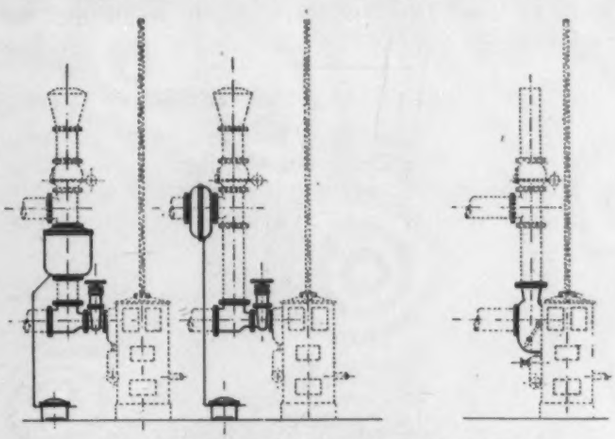


Fig. 5. Diagram of Cut-Out Valve Heater.

surplus exhaust to be taken care of over what is required to heat the boiler feed.

Cut-Out Valve Heater.

The important thing about this new heater, Fig. 4, is that the oil separator is large enough to purify all of the exhaust steam delivered by the engines, including the surplus that goes to the heating system, as well as the steam condensed in heating the water in the heater.

By the invention of the open heater, it became possible for one compact apparatus to at once act as hot well, expansion tank, filter, skimmer and make-up water regulator. The new heater has also independent separator, trap, valves and connections for the by-pass. It combines the simplicity and compactness of the thoroughfare arrangement with provision for purifying the surplus exhaust and for cutting the heater out for cleaning while the heating system is in operation. These features are essential to a complete and properly installed "induction," or "draw-the-supply," arrangement.

After the steam has been purified of oil in the separator of this heater, it can either enter the heater shell to heat the feed water or it can escape through the surplus opening or "steam stack," the parts being so placed that the heater has the preference. The steam inlet opening on the separator is in the usual position, while the exhaust opening is at the top of the separator. A vent pipe from the top of the heater provides for the escape of air and gases.

This new arrangement saves not only the cost of an independent separator but also the expense and cost of installing the T's, elbows and the short pieces of pipe that would be required for the installation of by-pass around an old style heater and receiver.

In order that it may be possible to cut the heater out of service for inspection or cleaning while the heating system continues to receive purified exhaust steam through the separator, a semi-rotary valve is arranged to close the passage between the separator and the heater. This valve takes the place of two or more large gate valves required to accomplish the same results where a three-valve by-pass is installed around the old style heater.

To prevent the escape of steam through the separator drain pipe into the heater while the latter is opened, another cut-out valve is placed in the passage between the trap and the heater overflow. Installations have been made where a saving of $500 in the cost of labor and material alone has been realized, as compared with the cost of installing the old style heater and by-pass.

Complete Purification.

Returning again to the purification of feed water, this is an item that confronts most boiler users as a practical problem. Nearly all boiler feed waters contain some scale-forming matter, and statistics collected by the leading inspection and insurance companies show that about one boiler out of every two examined by them is defective in ways that are traceable by impure water.

Scale in boilers means a consumption of an extra amount of fuel in order to force the heat through scale; expenditure to additional boilers to supply steam that the present boilers could furnish if kept clean; outlay for boiler cleaning and for replacements and repairs following upon the use of impure boiler feed water; the cost of firing up boilers put out of service for repairs, cleaning, etc., and, finally, the extra annual depreciation charge on boilers, the life of which is greatly shortened by corrosion, pitting, forcing, cleaning, temperature strains caused by overheating, etc.

The boiler owner wants a commercially practical system of water softening, one that will give the best results as measured by fuel efficiency, and low cost for installation, maintenance and repairs. He further wants a system that is easy to operate and that does not compel him to maintain a chemical laboratory.

If it is attempted to meet these conditions with boiler compounds, it is found that, while they may turn hard scale-forming impurities into sludge, they bring about all the precipitation in the boiler, where the precipitated matter is liable to bake onto the boiler plates and cause burning of plates, besides causing framing.

Boiler tube cleaners are only a makeshift for temporarily remedying an evil that should be prevented. Taking into consideration the men's time, cost of water, cost of cleaners and repair parts, damage to boilers, cost of fuel for firing the boilers up to steam again and interest on plant while idle, boiler cleaning will cost about $1 per h.p. for each cleaning. Further, scale begins to build up again the next day after cleaning and loss of boiler efficiency becomes greater

and greater until the incrustation reaches a maximum which justifies cleaning again. With some waters it is necessary to clean the boilers every two months or oftener.

Live steam purifiers have been installed for the removal of permanent hardness, but they are unsatisfactory and ineffective for several reasons. They do not remove all the scale-forming matters, since calcium sulphate is not precipitated from the feed water even at steam temperature, but will be thrown down only after the solution has been concentrated in the boiler. Live steam purifiers are operated under full boiler pressure; they radiate a considerable amount of heat (from ½ to 4 lb. of fuel per sq. ft. per hour); they must be located above the boiler level, and unless special provision is made and special attention given, the corrosive gases liberated from the water are passed over into the boiler; they are peculiarly subject to water hammer; and, finally, they make no provision for the utilization of exhaust steam.

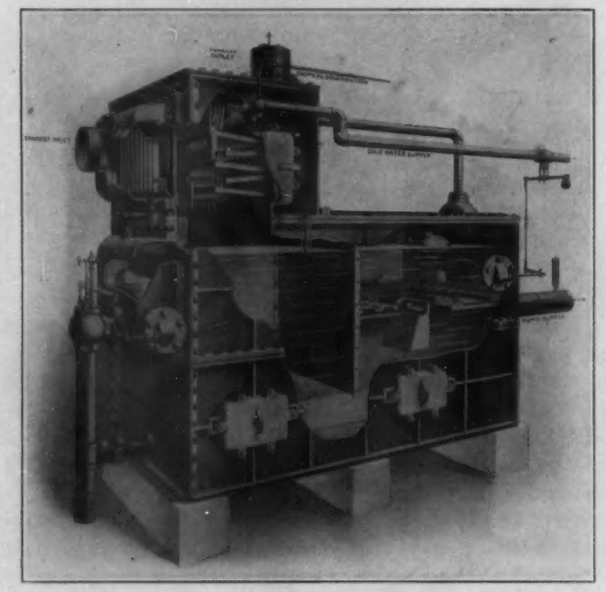


Fig. 6. Hot Process System.

Cold process systems are widely used for softening water in places where heat is non-available, as on railways for locomotive use, but as compared with our hot process system of water softening they involve the purchase of an additional chemical (usually caustic lime or soda), the erection of large, cumbersome tanks and of housing for same, sometimes the pumping of the entire water supply, the lifting of chemicals to a considerable height, expert attention for frequent analyses of the water and for the proportioning and mixing of several chemicals.

This brings us logically to the hot process system, Fig. 6. The chemical reaction involved in softening water is accelerated and assisted by heat; in fact, heat will quite effectively throw down carbonates by driving off the carbonic acid gas which holds them in solution in the water. This leaves only the sulphates, nitrates, chlorides and acids, and all these can be neutralized by one chemical, which is, in fact, the cheapest effective water-softening agent upon the market. Further, where only one chemical is used, the test to indicate whether enough, too much, or too little is used is very simple, and proportioning of the chemical feed correspondingly easy.

The hot process system takes advantage of the fact that boiler feed water should be heated in any case. The purification is already more than half accomplished when the water has been heated in the right kind of heater, and this apparatus takes up the work where the heater leaves off. The functions of the heater are extended so that it not only throws the carbonates out of solution, thereby dispensing with the cost of caustic lime or soda and avoiding the danger of large quantities of scale-forming matter being introduced into the boiler in case the feed of lime should not be exactly proportioned to the amount of carbonates present in the water, but also, so that the one chemical needed can be fed automatically, while further provision is made for the efficient removal of the precipitates by side mutation and filtration.

PRACTICAL MECHANICS.

Paper No. 14.

The Design of Gearing.

Before proceeding with the practical design of gear teeth, it will be well to define some of the terms

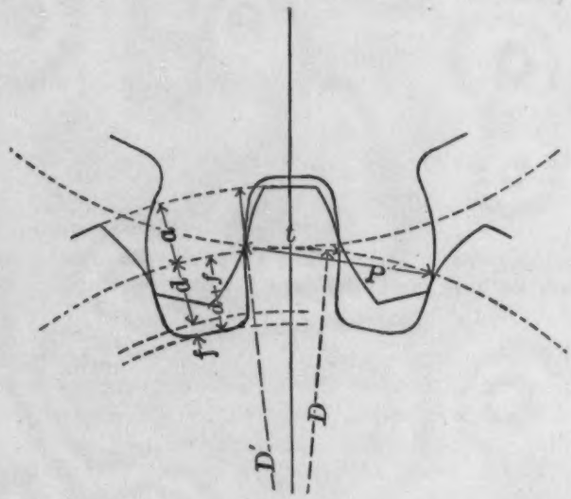


Fig. 16.

with which the designer will be concerned. In Fig. 16 P^1 indicates the circular pitch. This is the distance in inches between similar faces of teeth measured on the pitch circle. This value P^1 must be a certain definite fraction of the whole circumference, since there cannot be other than a whole number of teeth. Hence $P^1 \times N$, the number of teeth $= C$, the circumference, or it may be written $P^1 = \frac{C}{N}$.

There is another term known as the diametral pitch, which is used. This (denoted by P and not possible of measurement in the figure) is the value representing the number of teeth per inch of diameter.

Thus, if D is the diameter in inches $P = \frac{N}{D}$.

Now, since the ratio between the circumference and the diameter of a circle is represented by π, then

$C = \pi \times D$ and hence $P^1 = \frac{\pi \times D}{N.}$ But $\frac{N}{D}$ being equal to P, $\frac{D}{N} = \frac{1}{P}$ and so $P^1 = \pi \times \frac{1}{P}$ or $\frac{\pi}{P}$.

The usefulness of this term diametral pitch will be brought out later.

In the figure (a) is called the addendum, and is that part of the tooth extending above the pitch circle. From the pitch circle the distance (d) is called the working depth of the tooth, and equals (2a). An additional space (f), the clearance, is provided to prevent the top of the tooth from coming in contact with the bottom of the space which it occupies in the other gear.

The thickness of the tooth is (i); the pitch diameter D; and the outside diameter D.

The addendum (a) is ordinarily chosen equal to $\frac{1}{P}$, thus permits the following relations which may be shown mathematically:

(1) $a = .318\,P^1$ the addendum.

(2) $D^1 = \frac{N+2}{P}$ the outside diameter.

(3) $2a + f = \frac{2.157}{P}$ the total depth of space.

These formulae give the necessary data to enable the machinist to proceed with the actual cutting of the teeth.

The formula $P = \frac{N}{D}$ gives the relations between size, pitch, and number of teeth. Knowing P and N the second formula gives the overall diameter of the disc when turned ready for cutting the teeth. The last formula gives the depth of the cut into the disc. If now the machinist is provided with the proper template and has worked out the number of teeth, etc., he can proceed with the actual cutting of the teeth.

A method for closely approximating the outlines of cycloidal teeth has been worked out by Mr. George B. Grant. This consists of using the average radius of curvature of the cycloidal arc as the radius of a circle whose arc will very nearly coincide. On this approximation the following table has been worked out. This is inclusive of gears with any number of teeth from a pinion of ten to a rack, i. e., an infinite number.

THREE-POINT ODONTOGRAPH
Standard Cycloidal Teeth
From a Pinion of Ten Teeth to a Rack

Number of Teeth		For one Diametrical Pitch. For any Other Pitch, divide by that Pitch.				For One-inch Circular Pitch. For any other Pitch, multiply by that Pitch.			
		Faces		Flanks		Faces		Flanks	
Exact	Interval	Rad.	Dis.	Rad.	Dis.	Rad.	Dis.	Rad.	Dis.
10	10	1.99	.02	—8.00	4.00	.62	.01	—2.55	1.27
11	11	2.00	.04	—11.05	6.50	.63	.01	—3.34	2.07
12	12	2.01	.06			.64	.02		
13.5	13-14	2.04	.07	15.10	9.43	.65	.02	4.80	3.00
15.5	15-16	2.10	.09	7.86	3.46	.67	.03	2.50	1.10
17.5	17-18	2.14	.11	6.13	2.20	.68	.04	1.95	.70
20	19-21	2.20	.13	5.12	1.57	.70	.04	1.63	.50
23	22-24	2.26	.15	4.50	1.13	.72	.05	1.43	.36
27	25-29	2.33	.16	4.10	.96	.74	.05	1.30	.29
33	30-36	2.40	.19	3.80	.72	.76	.06	1.20	.23
42	37-48	2.48	.22	3.52	.63	.79	.07	1.12	.20
58	49-72	2.60	.25	3.33	.54	.83	.08	1.06	.17
97	73-144	2.83	.28	3.14	.44	.90	.09	1.00	.14
290	145-300	2.92	.31	3.00	.38	.93	.10	.95	.12
	Rack	2.96	.34	2.96	.34	.94	.11	.94	.11

To use the table it is necessary to draw the pitch circles and then the circles of face and flank centers at distances inside of or outside of the pitch circle corresponding to the values given. Thus in a 20-tooth pinion the centers for drawing the tooth faces would lie on a circle whose radius would be .13 inches less than the radius of the pitch circle, while the flank curve centers would fall on a larger circle, the radius

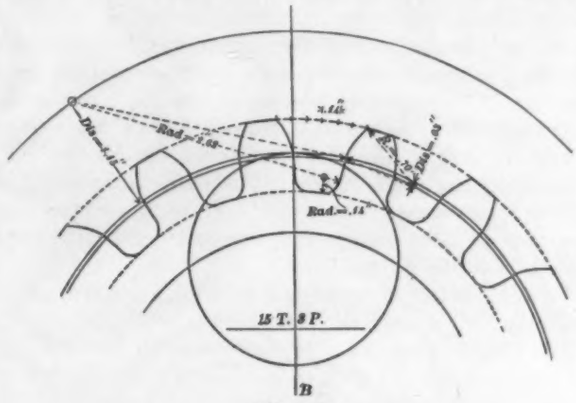


Fig. 17.

of which would be 1.57 inches greater than the pitch circle radius. Having drawn these circles the tooth intervals may be laid out on the pitch circle and then with the radius as indicated and centers on the flank circle, the flank curves may all be drawn in; with corresponding face radius and centers on the inner circle. The face centers are then drawn from the pitch circle out to the outer circle. It is to be noted that the values in the table are for a diametral pitch of one, and that for other pitches the numbers given are divided by the pitch. Fig. 17 shows the construction for a 15-tooth 3-diametral pitch gear. Dividing the

THREE-POINT ODONTOGRAPH
Standard Involute Teeth
Obliquity 15°

Number of Teeth	For one Diametrical Pitch. For any Other Pitch, divide by that Pitch.		For One-inch Circular Pitch. For any Other Pitch, multiply by that Pitch.	
	Face Rad.	Flank Rad.	Face Rad.	Flank Rad.
10	2.28	.69	.73	.22
11	2.40	.83	.76	.27
12	2.51	.96	.80	.31
13	2.62	1.09	.83	.34
14	2.72	1.22	.87	.39
15	2.82	1.34	.90	.43
16	2.92	1.46	.93	.47
17	3.02	1.58	.96	.50
18	3.12	1.69	.99	.54
19	3.22	1.79	1.03	.57
20	3.32	1.89	1.06	.60
21	3.41	1.98	1.09	.63
22	3.49	2.06	1.11	.66
23	3.57	2.15	1.13	.69
24	3.64	2.24	1.16	.71
25	3.71	2.33	1.18	.74
26	3.78	2.42	1.20	.77
27	3.85	2.50	1.23	.80
28	3.92	2.59	1.25	.82
29	3.99	2.67	1.27	.85
30	4.06	2.76	1.29	.88
31	4.13	2.85	1.31	.91
32	4.20	2.93	1.34	.93
33	4.27	3.01	1.36	.96
34	4.33	3.09	1.38	.99
35	4.39	3.16	1.39	1.01
36	4.45	3.23	1.41	1.03
37-40	4.20		1.34	
41-45	4.63		1.48	
46-51	5.06		1.61	
52-60	5.74		1.83	
61-70	6.52		2.07	
71-90	7.72		2.46	
91-120	9.78		3.11	
121-180	13.38		4.26	
181-360	21.62		6.88	

In all cases the centers are on the base circles. Draw rack by special method described in text.

face distance given in the table .09 by 3 gives .03 inches, as shown, while the radius for face curve is 2.1 inches, divided by 3, or .7 inches. The values for the flank circle and radius will be seen to be similarly obtained. The above table was constructed to correspond with cycloidal gear teeth as drawn out by a describing circle equal in diameter to the radius of a gear of 12 teeth. For other sizes of describing circles the values of approximate circle radii would of course be different.

For involute teeth Mr. Grant has worked out a similar table of radii for drawing approximate circular arcs. The centers are taken on the base circles, the flank radius being used from the base circle to the pitch circle and the face radius to describe the arc outside of the pitch circle. Using this approximation it becomes necessary to round off the tips of the teeth to prevent interference and the bases are also flared out to give strength.

Prof. Marx gives as a guide for good design the following: Width of face = 3 times the circular pitch and basing his calculations upon the strength of the weakest section of the tooth, he derives the following formula for the tooth dimensions:

$$(4)\quad F = f \times P^1 \times 6\left(0.124 - \frac{0.684}{N}\right)$$

where

F = the working force as worked out in paper No. 12.

f = the allowable stress in lbs. per sq. in. of section.

6 = width of face, and P^1 = circular pitch.

For cast-iron and steel the following values for (f) are conservative:

Velocity of pitch line in ft. per min.	100	200	300	600	900	1,200	1,800	2,400
f for steel.....	20,000	15,000	12,000	10,000	7,500	6,000	5,000	4,300
f for cast iron..	8,000	6,000	4,860	4,000	3,000	2,406	2,000	1,700

Some practice will be necessary to enable the designer to obtain the correct proportions between the circular pitch and the width. By several trials, however, assuming certain proportions from a general knowledge of the good appearance of gear-teeth the right dimension, consistent with sufficient strength, will be arrived at. For instance, assume a circular pitch which would seem about right, divide it into the circumference of the pitch circle and thus get the number of teeth. This number must of necessity be a whole round number, since there cannot be a fraction of a tooth and, hence, it will be necessary to take the number nearest that above found and divide back to get the exact pitch. Having obtained this take (b) as three times as large and substitute in the formula (4) and find (f). If the value is very different from that given in the above table for the same velocity another trial will be necessary.

Due to lack of space a complete problem will not be worked out here but should the reader experience difficulty in working out a gear design in accordance with the above outline the Journal will be pleased to have such reader correspond with the editor of the Steam Engineering Department for assistance.

Believing that anyone wishing to master the design of bevel gears will be sufficiently interested to go more completely into the subject than is possible in this series of papers, we shall dispense with that specific case by referring such readers to Le Conte's Mechanics of Machines, Smith & Max Machine Design, and Robinson's Principles of Mechanism.

This will complete the series of papers on the mechanics of transmission, all of the cases originally set forth having been covered in greater or less detail.

CALIFORNIA FUEL OIL.

BY R. F. CHEVALIER.

(Continued.)

Combustion.

From various authorities the ultimate analyses of California oils show them to contain from 81 to 87 per cent of carbon, 11 to 13 per cent of hydrogen, about 1 per cent sulphur, a small amount of nitrogen and oxygen and some water.

Air Supply Required—If a fuel contains oxygen, all the hydrogen shown by analyses is not available for the production of heat. This oxygen is in combination with part of the hydrogen as water, or H_2O, and as the atomic weights of H and O are 1 and 16 respectfully, the weight of the combined hydrogen will be one-eighth the weight of the oxygen, or available hydrogen = H — ⅛ O. From table No. 3 we can calculate the air required for combustion, using the following formula:

Carbon × 2⅔ = lb. O required for C.

$$\left(\text{Hydrogen} - \frac{\text{O in fuel}}{8}\right) \times 8 = \text{lb. O required for C.}$$

Sulphur × 1 = lb. O required for S.

The ultimate analyses of the average fuel oil used may be assumed as follows:

Carbon	86 per cent.	Oxygen	1 per cent.
Sulphur	0.8 per cent.	Nitrogen	0.2 per cent.
Hydrogen	12 per cent.		

By use of table No. 3 and the above formula, the air required per pound of fuel is easily calculated.

TABLE NO. 3.

OXYGEN AND AIR REQUIRED FOR THE COMBUSTION OF CARBON, HYDROGEN, ETC.

Combustible.	Chemical Reaction.	Product of Combustion.	lb. of Oxygen	lb. of Nitrogen	lb. of Air	lb. of Gaseous Products	Heat generat'd B. t. u.
Carbon	$C+2O=CO_2$	Carbon Dioxide	2 2/3	8.85	11.52	12.52	14,600
Carbon	$C+O=CO$	Carbon Monoxide	1 1/3	4,43	5.76	6.76	4 450
Carbon Monoxide	$CO+O=CO_2$	Carbon Dioxide	4/7	1.90	2.47	3.47	10.150
Hydrogen	$2H+O=H_2O$	Water	8	26.56	34.56	35.56	62.000
Methane	$CH_4+4O=CO_2+2H_2O$	Carbon Dioxide and Water.	4	13.28	17.28	18.38	23,550
Sulphur	$S+2O=SO_2$	Sulphur Dioxide	1	3.33	4.32	5.32	4,050

$.86 \times 2\frac{2}{3} =$ 2.2933 lb. oxygen.
$(.12 - \frac{.01}{8}) =$ .95 " "
$.008 \times 1 =$ .008 " "
Total = 3.2513 lb. oxygen.

As one pound of oxygen is contained in 4.32 pounds of air, the total amount of air required would be 3.2513 X 4.32 = 14.045 lb.

To better illustrate the combination of the elements in oil fuel with air during combustion, and the steam used to atomize the oil, the following tabular view has been arranged. It is assumed that to atomize one pound of oil .5 of a pound of steam is required.

TABULAR VIEW OF FURNACE COMBUSTION.

			Pounds.		Waste Products in Chimney.	Pounds.	Per cent. by weight.
Entering Furnace	1 pound Fuel Oil	Carbon	.86		CO_2	3.1533	20.3%
		Hydrogen	.12		Steam (H_2O)	1.58	10.17
		Oxygen	.01		CO	0.00	0.0
		Nitrogen	.002		SO_2	.016	0.1
		Sulphur	.008		N	10.7963	69.43
	14.0456 pounds Air	Oxygen for CO_2	2.2933			15.5456	100.00
		Oxygen for H_2O	.95				
		Oxygen for CO					
		Oxygen for SO_2	.008				
		Nitrogen	10.7943				
	Atomizing Agent	Steam	.5				

Comparison of Combustion of Coal and Oil.—In burning bituminous coal, when fresh fuel is thrown on a fire, it is heated by the coal already burning and combustible gases are distilled which mingle with the oxygen and burn back of the bridge wall in the space known as the combustion chamber. The coke that is left burns on the grate with very little flame. In this way half of the heat is generated by the burning gases in the combustion chamber, and the balance is generated by the hot coals on the grates in the furnace. A large part of the air entering for combustion must pass through the hot coals where part of the oxygen is used, the remainder passing on to mingle with the gases distilled from the coal, in the combustion chamber. As gases tend to move in straight lines, considerable excess air is required for their diffusion, unless thrown out of the line of their travel by a bridge wall or other obstruction.

With liquid fuel the first requirement is complete atomization. Before oil can be mixed with the air in a furnace it must be converted into a vapor by the radiant heat of the furnace.

Oil leaves a residue of coke when it is vaporized. On leaving the burner-tip the oil commences to evaporate while traveling across the furnace, and the gase, mixing with the air, burns immediately. The residue, which is the carbon in the form of small specks of coke, will burn providing it is not deposited on the floor or side-wall of the furnace before being consumed. If these carbon deposits are of the consistency of asphalt, they will form a hard deposit difficult to remove, impairing the draft and causing more accumulation of carbon.

Carbon burns more slowly than gas. From this we may assume that the dazzling white part of an oil flame near the burner is caused by the combination of hydrogen and hydrocarbon gases with oxygen, and the more luminous or orange tinged part of the flame furtherest from the burner-tip is due to the combustion of the carbon. This fact is borne out by the temperature of oil flames determined by the writer, the data of which will be given later.

(To be Continued.)

TABLE NO. 4.

Weights and Gravities of Fuel Oils at 60° Fahr.

Beaumo scale gravity	Specific gravity	Wgt. per gal. in lbs.	Wgt. per cu. ft. lbs.	Wgt. per bbl. in lbs.	Gallons per ton	Bbls. per ton	Cu. ft. per ton
10	1.0000	8.33	62.5	349.86	268.9	6.40	35.84
11	.9929	8.27	62.06	347.34	270.8	6.44	36.09
12	.9859	8.21	61.6	344.82	272.9	6.49	36.5
13	.9790	8.16	61.2	342.72	274.5	6.53	36.6
14	.9722	8.10	60.8	340.20	276.5	6.58	36.8
15	.9655	8.04	60.34	337.68	278.6	6.61	37.1
16	.9589	7.99	59.9	335.58	280.3	6.67	37.4
17	.9523	7.93	59.5	333.06	282.4	6.72	37.6
18	.9450	7.88	59.1	330.96	284.2	6.77	37.9
19	.9395	7.83	58.7	328.86	286.	6.81	38.1
20	.9333	7.78	58.33	326.76	287.9	6.88	38.6
21	.9271	7.72	58.	324.24	290.	6.9	38.6
22	.9210	7.67	57.6	322.14	292.	6.95	38.9
23	.9150	7.62	57.2	320.04	294.	7.00	39.1
24	.9090	7.57	56.8	317.94	295.9	7.04	39.4
25	.9032	7.53	56.45	316.26	297.4	7.08	39.7

ECONOMY IN USE OF OIL ON P. R. R.

A comparison of the amounts of oil and grease issued to Panama railroad locomotives for the months of January, February and March, 1909 and 1910, shows the following saving or excess:

	Gallons		
Oil:	1909	1910	Saving
Valve	1,558	778	780
Engine	1,598	1,200	398
Car	436	18	418
Signal	484	65	419
Headlight	459	349	110
Machine	2	*1	...
Coal	193	143	50
Lard	*1	†2	...

*One month. †Two months.

	Pounds		
	1909	1910	Saving
Tallow	*4	†14	...
Cup grease	301	330	‡29
Cotton waste	2,927	1,475	1,452
Woolen waste	242	279	‡37
White waste	...	42	‡42

*One month. †Two months. ‡Excess in 1910 over 1909.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER VII.

(Continued.)

Testing with Indicating Instruments.

The voltmeter and ammeter method can only be used with direct current watt hour meters, or with alternating current watt hour meters when the power factor is unity or its exact value known; the connections for this method are shown in Fig. 87, where V is the voltmeter, A is the ammeter and W the single phase watthour meter being tested. If E is the

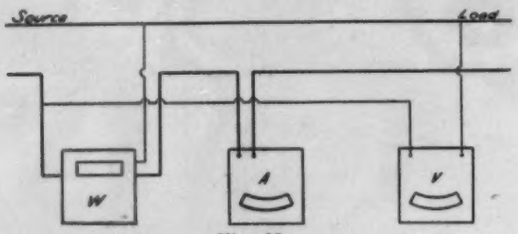


Fig. 87.

voltage impressed upon the circuit, and I the current in amperes, then the power (unity power factor) is P=E x I.

The indicating wattmeter method of testing watt hour meters is applicable to alternating currents regardless of what the power factor may be, so with this method the power, P, is read direct. Fig. 88 shows the connections for this method of testing.

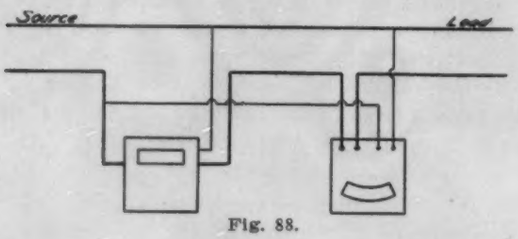


Fig. 88.

Each revolution of the meter disc represents a certain number of watt hours of electrical energy passing through the meter, which is given in some types of meters directly in the form of the meter "constant," and in such meters, if R is the number of revolutions of the disc in t seconds (as measured with a stop watch), and with constant power passing through the meter, then the watt hours would be =R x K, where K is the meter "constant." But the power P=watt seconds per second=watt hours x 3,600 divided by the time, t, therefore we have

$$P = \frac{R\ K\ 3{,}600}{t}$$

The constant, K, for the General Electric meters will be found marked on the meter disc, and are also reproduced in the accompanying tables.

DIRECT CURRENT METERS.

Amps.	100-120 Volt Type C-6 Meter "K"	Reg. Ratio	Dial Const.	Watts per r.p.m.	200-240 Volt, 2 and 3 wire, Type C-6 Meter "K"	Reg. Ratio	Dial Const.	Watts per r.p.m.	500-600 Volt Type C-7 Meter "K"	Reg. Ratio	Dial Const.	Watts per r.p.m.
5	.2	500	none	12	.4	250	none	24	1	100	none	60
10	.4	250	"	24	.75	133.33	"	45	2	50	"	120
15	.6	166.66	"	36	1.25	80	"	75	3	33.33	"	180
25	1.0	100	"	60	2.00	50	"	120	5	20	"	300
50	2.0	50	"	120	4.00	25	"	240	10	10	"	600
75	3.0	33.33	"	180	6.00	16.66	"	360	15	66.66	10	900
100	4.0	25	"	240	7.50	13.33	"	450	20	50	10	1200
150	6.0	16.66	"	360	12.50	80	10	750	30	33.33	10	1800
300	12.5	80	10	750	25.00	40	10	1500	60	16.66	10	3600
600	25.0	40	10	1500	*50.00	*20	10	300	125	80	100	7500

*Applies to 600 amperes, two wire meters only; 600 ampere, three wire meters are not manufactured.

General Electric, Type "I," Standard 60 Cycle, Single Phase Watthour Meters.

Amps.	100-130 Volt 2 Wire Meter "K"	Watts per r.p.m.	200-260 Volt 2 and 3 Wire Meter "K"	Watts per r.p.m.	500-600 Volt Meter "K"	Watts per r.p.m.
3	.2	12	.4	24	1	60
5	.3	18	.6	36	1.5	75
10	.6	36	1.25	75	3	180
15	1	60	2	120	5	300
25	1.5	90	3	180	7.5	450
50	3	180	6	360	15	900
75	5	300	10	600	25	1500
100	6	360	12.5	750	30	1800
150	10	600	20	1200	50	3000
200	12.5	750	25	1500	60	3600
300	20	1200	40	2400	100	6000
			Polyphase, 60 Type "D-3."			
3	.4	24	.75	45	2	120
5	.6	36	1.25	75	3	180
10	1.25	75	2.5	150	6	360
15	2	120	4	240	10	600
25	3	180	6	360	15	900
50	6	360	12.5	750	30	1800
75	7.5	450	15	900	40	2400
100	12.5	750	25	1500	60	3600
150	15	900	30	1800	75	4500

For General Electric meters used with current and potential transformers, but calibrated without them, the constant to be used is that marked on the meter disc, divided by the product of the ratios of the potential and current transformers. The worm reduction in all General Electric meters is 100 and will be found stamped on the back of the register. The register ratio multiplied by 100=number of revolutions of disc for one revolution of the right hand pointer. In all cases, the meter, K, is the actual number of watt hours per revolution of the disc.

$$\text{Meter Constant, } K = \frac{\text{*Rating in (volt-amperes)}}{\text{Full load r.p.m. of disc x 60}}$$

$$\text{Register Ratio} = \frac{\text{Watt hours of right hand dial}}{\text{Worm reduction x K}}$$

(*For polyphase meters, the rating should be multiplied by 2. In case a meter has a double rating, such as 110/220 volts, the latter voltage should be applied in the formula. The approximate full load speed of all G. E. type "I" and "D-3," 60 cycle meters is 30 r.p.m.)

Westinghouse Meter Constants.

For different makes of meters, the testing formula given takes a different form since the constant K is made to embrace different factors.

For the Westinghouse meter, the formula becomes

$$P = \frac{R \times K}{t}$$

where K represents the **watt-seconds** for one revolution of the meter disc.

The values of the constant, K, for the Westinghouse types B and C and for the direct current meters are as follows:

2-wire D. C. and self-contained single phase, K = volts x amps x 2.4;

2-wire single phase used with *current* transformers *only* (but checked without), K = volts x 5 x 2.4;

2-wire, single phase used with *current* and *potential* transformers (but checked without), K = 5 x 100 x 2.4;

2-wire, single phase, used with transformers of either or both forms (and checked with), K = volts x amps x 2.4;

3-wire, single phase, self-contained, K = volts x amps. x 4.8.

3-wire, single phase, used with current transformers (but checked wtihout), K = volts (as marked on meter) x 12;

Type "C" polyphase, self-contained, K = volts x amps x 4.8;

Type "C" polyphase, used with *current* transformers only (but checked without), K = 5 x volts x 4.8;

Type "C" polyphase, used with current and potential transformers (but checked without), K = 2400;

Type "C" polyphase used with transformers of either or both forms (and checked with), K = volts x amps x 4.8.

In all cases, the volt and ampere values referred to are those as marked on the name plate of the meter. The full load speed of the types B and C is 25 r.p.m. For the Westinghouse type A meter, the full load speed is 50 r.p.m., and the constant, K, for this type is exactly one-half the value of a similarly rated type C meter.

Fort Wayne Type K Meter.

The calibrating equation of the Fort Wayne type K meter is as follows:

$$P = \frac{R \times K \times 100}{t}$$

where t is the time in seconds during which the meter makes R revolutions, and where K is the constant, which will be found in the following tables:

Fort Wayne, Type "K," Single Phase, 60 Cycle Watthour Meters whose Serial Number is 344,999 or less.
Values of the Constant, K.

Amps.	2 wire 50 volt	2 wire 110 volt	2 wire 220 volt	3 wire 220 volt	2 wire 550 volt	2 wire 1100 volt	2 wire 2200 volt
3	..	9	18	18	45	90	90
5	9	9	18	18	45	90	180
7.5	..	..	..	27	..	..	..
10	9	18	36	36	90	180	360
15	18	36	54	54	180	360	540
20	18	36	72	72	180	360	720
25	18	36	72	72	180	360	900
30	36	72	90	90	360	720	1080
40	36	72	108	108	360	720	1440
50	36	72	144	144	360	720	1800
60	54	108	180	180	540	1080	2160
75	54	108	216	216	540	1080	2700
100	72	144	288	288	720	1440	3600
125	90	180	360	360	900	1800	4500
150	108	216	432	432	1080	2160	5400
200	144	288	576	576	1440	2880	7200
250	180	360	720	720	1800	3600	9000
300	270	540	1080	1080	2700	5400	10800
400	360	720	1440	1440	3600	7200	14400
500	450	900	1800	1800	4500	9000	18000
600	540	1080	2160	2160	5400	10800	21600
800	720	1440	2880	2880	7200	14400	28800
1000	900	1800	3600	3600	9000	18000	36000
Use These Constants for High Torque Meters.							
15	13.5	27	54	54	135	270	540
30	27.0	54	90	90	270	540	1080

Fort Wayne, Type "K," Single Phase, 60 Cycle Watthour Meters, whose Serial Number is 345,000 or above.
Values of the Constant, K.

Amps.	2 wire 110 volt	2 wire 220 volt	3 wire 220 volt	2 wire 440 volt	2 wire 550 volt	2 wire 1100 volt	2 wire 2200 volt
5	9	18	18	36	45	90	180
10	18	36	36	72	90	180	360
15	27	54	54	108	135	270	540
20	36	72	72	144	180	360	720
25	45	90	90	180	225	450	900
40	72	144	144	288	360	720	1440
50	90	180	180	360	450	900	1800
75	135	270	270	540	675	1350	2700
100	180	360	360	720	900	1800	3600
125	225	450	450	900	1125	2250	4500
150	270	540	540	1080	1350	2700	5400
200	360	720	720	1440	1800	3600	7200
300	540	1080	1080	2160	2700	5400	10800
400	720	1440	1440	2880	3600	7200	14400
600	1080	2160	2160	4320	5400	10800	21600
800	1440	2880	2880	5760	7200	14400	28800

Fort Wayne, Type "K," Polyphase Meters whose Serial Number is 344,999 or less.
Values of the Constant K.

Amps.	110 v.	220 v.	440 v.	550 v.	1100 v.	2200 v.
3	18	36	72	90	180	360
5	36	72	144	180	360	720
10	72	144	288	360	720	1440
15	108	216	432	540	1080	2160
20	144	288	576	720	1440	2880
25	144	288	576	720	1800	3600
30	216	360	720	1080	2160	4320
40	288	576	1152	1440	2880	5760
50	288	576	1152	1440	3600	7200
60	432	864	1728	2160	4320	8640
75	432	864	1728	2160	5400	10800
100	576	1152	2304	2880	7200	14400
125	720	1440	2880	3600	9000	18000
150	864	1800	3600	4320	10800	21600
200	1440	2880	5760	7200	14400	28800
250	1800	3600	7200	9000	18000	36000
300	2160	4320	8640	10800	21600	43200
400	2880	5760	11520	14400	28800	57600
500	3600	7200	14400	18000	36000	72000
600	4320	8640	17280	21600	43200	86400
800	5760	11520	23040	28800	57600	115200
1000	7200	14400	28800	36000	72000	144000

Fort Wayne, Type "K" Polyphase Meters whose Serial Number is 345,000 or above.
Values of the Constant, K.

Amps.	110 v.	220 v.	440 v.	550 v.	1100 v.	2200 v.
5	36	72	144	180	360	720
10	72	144	288	360	720	1440
15	108	216	432	540	1080	2160
25	180	360	720	900	1800	3600
50	360	720	1440	1800	3600	7200
75	540	1080	2160	2700	5400	10800
100	720	1440	2880	3600	7200	14400
150	1080	2160	4320	5400	10800	21600
200	1440	2880	5760	7200	14400	28800
300	2160	4320	8640	10800	21600	43200
400	2880	5760	11520	14400	28800	57600
600	4320	8640	17280	21600	43200	86400
800	5760	11520	23040	28800	57600	115200

The Duncan Meter.

The formula for testing meters manufactured by the Duncan Electric Manufacturing Company is

$$P = \frac{R \times K \times 3600}{t}$$

which is the same as that previously given for the General Electric meter. The following is a table of testing constants:

	110 Volts		220 Volts		550 Volts	
Amps.	Meter "K"	Watts per r.p.m.	Meter "K"	Watts per r.p.m.	Meter "K"	Watts per r.p.m.
2.5	0.25	15	0.5	30	1	60
5	0.25	15	0.5	30	1	60
7.5	0.50	30	1	60	2	120
10	0.50	30	1	60	2	120
15	1	60	2	120	5	300
25	1	60	2	120	5	300
50	2	120	4	240	10	600
75	3	180	6	360	16	960
100	4	240	8	480	20	1200
150	6	360	12	720	30	1800
200	8	480	16	960	40	2400
300	12	720	25	1500	60	3600
450	20	1200	30	1800	80	4800
600	25	1500	50	3000	100	6000
800	30	1800	60	3600	160	9600

Sometimes it is necessary to use the formula already given for the determination of other values than the watts, P, and for convenience this formula is rewritten as follows:

$$(1)\ \text{Number of revolutions} = \frac{\text{Secs. during test x watts indicated}}{3600 \text{ x testing constant (K)}}$$

$$(2)\ \text{Testing constant} = \frac{\text{seconds during test x watts indicated}}{3600 \text{ x revolutions.}}$$

$$(3)\ \text{Seconds} = \frac{3600 \text{ x revolutions x testing constant}}{\text{watts indicated}}$$

The Sanmango Mercury Meter.

A description of the Sangamo Mercury Meter will be found in Chapter V., the table of calibrating constants being given below:

Amps.	100/125 volts.	200/250 volts.	500/600 volts.
5 A. C.	1,800	3,600	.....
5 D. C.	2,400	4,800	12,000
10	2,400	4,800	12,000
20	4,800	9,600	24,000
30	7,200	14,400	36,000
40	9,600	19,200	48,000
60	14,400	28,800	72,000
80	19,200	38,400	96,000
100	24,000	48,000	120,000
150	36,000	72,000	180,000
200	48,000	96,000	240,000
300	72,000	144,000	360,000
400	96,000	192,000	480,000
500	120,000	240,000	600,000
600	144,000	288,000	720,000
800	192,000	384,000	960,000
1000	240,000	480,000	1,200,000

The calibrating equation for the Sangamo is the same as for the Westinghouse meter, viz.:

$$P = \frac{R \times K}{t},$$

in which the constant, K = watt-seconds recorded by one revolution of the disc.

Larger capacity meters than given in the above table have proportionally greater values of K.

Three wire 110-220 volts A. C. meters have same constants as above given for the 200-250 volt meters.

Testing with the Portable Rotating Standard.

The third method of testing watthour meters, and probably the most convenient and the quickest for outside work, consists in using a portable standard watt hour meter, which is usually known as a "rotating standard." It is especially well adapted for the rapid testing of service meters at the point of installation. The portable standard eliminates the necessity of a stop watch, since the time element does not enter into account; furthermore, the load does not have to remain constant during the test, as is the case with both of the previously named methods; the only thing which has to be observed is the number of revolutions of the disc of the meter under test; the disc of the rotating standard is directly connected to the large or lowest reading pointer, and therefore indicates the actual number of revolutions which it makes. Figure 89 shows interior and exterior view of a typical type of rotating standard test meter. This type of meter is essentially an ordinary watthour meter with certain modifications. It is made with several different current coils whose leads are brought out to a connection block on the top of the meter or to a drum switch within, and that coil whose capacity is nearest the value at which the meter under test is operating can be connected in the circuit. By this means the test meter can always be made to operate at or near full load, therefore having its full load accuracy throughout a wide range. This is an excellent feature, as it insures accuracy over a wide range and also permits the use of one test meter for calibrating watthour meters of various sizes.

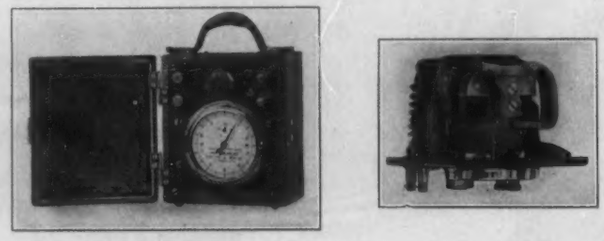


Fig. 89.

The rotating standard is made self-contained in the following sizes: Direct current, 110-220 volts, with current coils for 1, 2, 10, 20 and 40 amperes, or with current coils for 5, 10, 50 and 100 amperes; alternating current, 110-220 volts, with current coils for 1, 10 and 20 amperes, or with current coils for 1, 5, 10, 50 and 100 amperes. By means of "multipliers" or potential transformers, these instruments can be used on 440 and 550 volts.

The rotating standard is very carefully designed and is well built mechanically. The registering mechanism is simple, since, as previously stated, the disc shaft is directly connected to the lowest reading pointer. The complete dial is usually made up of two pointers, the ratio being such that the highest reading pointer will not repeat its reading within less time than about two and one-half minutes when operating at full load speed. The number of revolutions of the disc as indicated by the pointers, multiplied by the constant for the particular coil of the standard which is connected in circuit, gives the watt hours that have passed during the time it is connected to the circuit, or

P = R x K (Gen. Elec. Rotating Standard).

The accuracy of the meter under test is expressed by the following equation:

$$\text{Percentage of accuracy} = \frac{r \times k}{R \times K} \times 100, \text{ where}$$

r=revolutions of disc of meter under test;
k=constant of meter under test;
R=revolutions of rotating standard as indicated by register;
K=constant of coil being used in standard.

For General Electric meters, k is marked on the disc.

$$\text{For Westinghouse meters, } k = \frac{c \times \text{watt rating}}{3600},$$

where c is the value of the constant for Westinghouse meters.

$$\text{For Fort Wayne meters, } k = \frac{c}{36},$$ where "c" is the value of the constant as given for Fort Wayne meters.

In the case of the rotating standard, the value of the constant K for the individual coils is the same as in the standard service meters. For instance, the value of K for the 10-ampere coil in the rotating standard is the same as the constant for a 10-ampere service meter, so that when testing service meters with a rotating standard and at the same time using the coil of the standard meter which is of the same capacity as the meter under test, is is only necessary to compare the revolutions of the two meters, that is:

$$\text{Percentage of accuracy} = \frac{r}{R} \times 100, \text{ or the}$$

$$\text{Percentage of error} = \frac{r - R}{R} \times 100, \text{ where}$$

r=revolutions of the meter under test, and R= revolutions of standard.

Below is given a table of data to be used with the Westinghouse rotating standard when used in checking induction meters manufactured by the Westinghouse Company, the General Electric Company and the Fort Wayne Electric Works:

Service Meter. Non-Inductive			Rotating Meter	Revolutions of Westinghouse Rotating Standard for 94% to 106% Registration of Service Meter											
Cap. Amps.	Heavy Load	Light Load	Cap. Amps.	94 %	95 %	96 %	97 %	98 %	99 %	100 %	101 %	102 %	103 %	104 %	105 %	106 %
*Westinghouse - Type "B and C"																
5	25	...	5	2.66	2.62	2.60	2.57	2.53	2.525	2.50	2.475	2.450	2.427	2.404	2.381	2.358
10	25	...	10													
20	25	...	20													
40	25	...	40													
5	...	1.0	5	1.06	1.05	1.04	1.03	1.02	1.01	1.00	0.99	0.98	0.97	0.96	0.95	0.94
10	...	1.0	10													
20	...	1.0	20													
40	...	1.0	40													
80	15	...	40	3.191	3.138	3.085	3.032	3.061	30.3	30.0	2.970	2.941	2.912	2.883	2.854	2.826
80	...	1.0	40	2.13	2.11	2.09	2.06	2.04	2.02	2.0	1.98	1.96	1.94	1.92	1.90	1.88
General Electric - Type "I."																
3	30	...	5	1.865	1.835	1.805	1.776	1.747	1.718	1.690	1.662	1.635	1.608	1.581	1.555	1.530
3	...	2.0	5	1.89	1.86	1.83	1.80	1.77	1.74	1.71	1.68	1.65	1.63	1.60	1.58	1.55
5	30	...	5	2.838	2.792	2.746	2.701	2.657	2.613	2.570	2.528	2.486	2.445	2.404	2.364	2.325
10	30	...	10													
5	...	2.0	5	1.938	1.907	1.876	1.845	1.814	1.784	1.755	1.726	1.697	1.669	1.642	1.615	1.588
10	...	2.0	10													
15	30	...	20	2.375	2.337	2.299	2.262	2.225	2.189	2.153	2.118	2.083	2.049	2.016	1.983	1.951
15	...	2.0	20	1.900	1.870	1.840	1.810	1.780	1.751	1.723	1.695	1.667	1.640	1.613	1.587	1.561
25	30	...	20	3.563	3.506	3.449	3.393	3.338	3.284	3.230	3.177	3.125	3.074	3.024	2.975	2.926
50	30	...	40													
25	...	2.0	20	2.850	2.805	2.759	2.715	2.670	2.627	2.584	2.542	2.500	2.459	2.419	2.380	2.341
50	...	2.0	40													
Fort Wayne - Type "A"																
5	30	...	5	2.375	2.338	2.300	2.263	2.226	2.189	2.153	2.118	2.083	2.049	2.016	1.983	1.951
10	30	...	10													
30	30	...	40													
5	...	2.0	5	1.900	1.870	1.840	1.810	1.780	1.751	1.723	1.695	1.667	1.640	1.613	1.587	1.561
10	...	2.0	10													
40	...	2.0	40													
25	30	...	20	2.375	2.338	2.300	2.263	2.226	2.189	2.153	2.118	2.083	2.049	2.016	1.983	1.951
50	30	...	40													
25	...	2.0	20	1.900	1.870	1.840	1.810	1.780	1.751	1.723	1.695	1.667	1.640	1.613	1.587	1.561
50	...	2.0	40													

It is recommended that test be made at approximately 100% and 4% of full load, if loads are within range of standard meter. Load service meter so as to give revolutions stated in table, in approximately one minute.

*Westinghouse Round Pattern and Type "A" meters should make fifty R.P.M. at full load. Speeds given are for 100 and 60 volt meters. For 200 volt meters are tested, use one-half coil of standard meter, and speeds still apply. This note is not applicable to General Electric 40 Cycle "Type I." meters.

Fig. 90.

The constant of any coil of the Westinghouse rotating standard is the same as the constant of a Westinghouse service meter having the same ampere capacity as that coil, so that the meter under test and the standard should make the same number of revolutions if the meter under test is correct.

The general connections of the test meter are shown in Figure 91. After the connections have all been made the meter is started and stopped by simply closing or opening the little push button switch, S. The meter tester has only to close the potential circuit by means of this switch, note the number of revolutions made by the standard and by the meter under test and apply these values in the above formula, from which he can immediately obtain the percentage accuracy of the meter under test. If it is found to be too fast or too slow it should be adjusted as previously explained. Meters should be adjusted for accuracy both on full load and about 5 per cent load, and it should be within 2 per cent correct throughout this range.

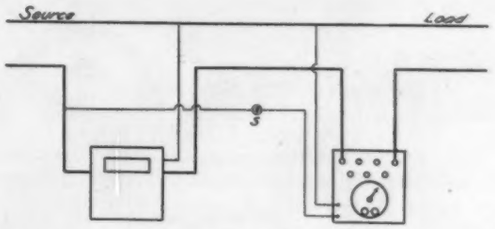


Fig. 91.

In using a portable rotating standard it should be remembered that it must be calibrated from time to time by checking it against laboratory standards.

When testing meters at the point of installation it is usually more convenient to have some kind of a "portable load," which will consist of a lamp bank or other resistance suitably mounted so that it may be carried from place to place, rather than to use the customer's load for testing purposes. With the "portable load" the tester can do his work quicker and he can get the exact load which he desires to put on the meter under test.

(To be continued.)

N. A. S. E. CONVENTION.

The seventh annual convention of the California State Association, N. A. S. E., together with an engineering and mechanical exhibit, will be held in Los Angeles, Cal., May 23 to 28, 1910. The meetings will be held in the Hamburger Building, on Eighth

Meeting Place for N. A. S. E., Los Angeles Convention.

street, between Hill and Broadway, and the headquarters will be maintained at Angelus Hotel.

Full details as to the plans for the meeting will appear in our issue of May 21st. Every indication points to a large and an enthusiastic gathering and we believe that all engineers will profit by attending the meetings.

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal." July 1895.
Entry changed to "The Journal of Electricity." September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas." August 15, 1899.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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Oil Gas Versus Steam

To pit an automobile against a mule on a mountain trail is as inconclusive of their relative merits as to compare a gas engine with a steam turbine under the premises assumed on another page by Mr. A. M. Hunt. Every prime mover is circumscribed by certain limitations. Here they include the fuel used, the locality and the special design necessary for emergency service.

The steam turbine plant proposed has the advantage of a splendid heritage, the experience of centuries. It is equipped with many devices suggested by engineering ingenuity, including heat storage and internal electric heaters. Figueratively it may be said to have a college education, whereas the gas engine is not out of the primary school.

This hypothetical steam turbine installation is compared with a pioneer gas engine plant that was built before many of the present refinments of steam engineering, and also gas engine practice, were available. The gas engines at Martin were built without precedent and have been the horrible example by which all subsequent engines have profited.

Mr. Hunt's figures show that both the first cost and the stand-by charges of his steam turbine plant would be less than half that of an oil gas engine plant of the same capacity. One can be put on the line as soon as the other and each has about the same efficiency, closely approximating one brake horsepower per pound of oil. He conclusively proves his contention that the steam turbine is the better for emergency service with oil fuel on the Pacific Coast.

Elsewhere it is otherwise. With the low-grade fuel utilized in some of the Eastern gas producers or with blast furnace gases the steam turbine would make as poor a showing as an automobile on a diet of thistles, the stand-by of the omnivorous jackass. Oil gas made by the Jones' process is too rich for the gas engine. It has a relatively high and perhaps inconstant percentage of hydrogen. This variable excess of hydrogen ratio is one of the causes of pre-ignition, for hydrogen, like nitro-glycerine, explodes suddenly. Carbon-monoxide, the other dynamic constituent of the gas, like black powder, burns more slowly. Ordnance experts have demonstrated that a slow burning powder, whose expansive force is continuously exerted on the bullet until it leaves the gun, not only gives greater velocity to the bullet, but also saves the gun. Likewise, a lean and slow burning gas gives the best results in an engine.

Other oil-gas processes have been devised, notably the Nix-Frost producer and the Amet-Ensign type, which show a lower hydrogen content. As yet these have been tried out in plants of but hundreds, where the Martin units are of thousands of horsepower. The engineer in the capacity of judge and not advocate will therefore withhold his decision until more data is available.

PACIFIC COAST MEETING A. I. E. E.

The first Pacific Coast meeting of the American Institute of Electrical Engineers was called to order in San Francisco by President Lewis B. Stillwell at 11 a. m. Thursday, May 5, 1910, with a registered attendance of one hundred and fifty. After a few opening remarks by President Stillwell, Secretary Pope made a number of announcements. An address of welcome to the visiting members was made by Professor Harris J. Ryan of Stanford University, local member of the High Tension Committee. In reply to this address, President Stillwell traced the growth of the Institute since its inception and dwelt upon a number of special problems that have recently presented themselves, including that of technical sections and the necessity for distant members participating in the general meetings. Judging from the success of the Charlotte, N. C., meeting and that in San Francisco, he concluded that the holding of such meetings under the auspices of any one of the six special committees has satisfactorily solved both these problems.

Mr. G. I. Rhodes, assistant engineer of the Interborough Rapid Transit Company of New York City, briefly discussed his paper on "Parallel Operation of Three-phase Generators With Their Neutrals Interconnected." In this paper he developed a mathematical explanation for the tripie harmonic that has been found to interfere with synchronizing three-phase, star-connected generators with their neutrals in parallel. To obviate this difficulty the author suggested that either the windings be so distributed over 120 degrees of space that no third harmonic potentials would be generated, or that the generator be designed with a uniform air-gap so that the distribution of the armature reaction flux will be the same as that of the magnetomotive force. In the discussion that followed it was questioned whether the third harmonic causes sufficient trouble to make the suggested changes in generator design advisable. In a contributed discussion, Mr. P. M. Lincoln attributed much of this trouble to the reciprocating engines. The discussion also included remarks on the advantages and disadvantages of grounding the neutral.

On Thursday afternoon Mr. P. M. Downing read his paper on "The Developed High Tension Network of a General Power System" as published in these columns on May 7, 1910. The interesting discussion which ensued will be published in these columns as soon as available.

On Friday morning, May 6, Mr. J. J. Frank's paper on "Observation of Harmonics in Current and Voltage Wave Shapes of Transformers" was abstracted and explained by Mr. G. Faccioli of Pittsfield, Mass. This paper shed much light on the hitherto little understood effect of the third harmonic on transformers. An interesting and valuable discussion followed, in the course of which Professor C. L. Cory suggested that this third harmonic which seems to be giving so much trouble may at some future period prove a most useful factor in reducing transmission line troubles.

On Friday afternoon Mr. A. H. Babcock read his paper on "Transmission Line Crossings of Railroad Rights of Way" as printed in this Journal May 7, 1910. During the course of the discussion several interesting types of protectors were discussed and the recommendation made that the proposals embodied in Mr. Babcock's paper be used as a basis for a standard agreement between the power companies and the railroads.

Later in the afternoon Mr. John Coffee Hays read an extended paper on "Hydro-Electric Development and Irrigation;" the facts and figures being based upon the operation of the Mount Whitney Power Company's system in Southern California. The discussion brought out more detailed figures of cost than were given in the paper, which will be published in an early number of the Journal.

On Saturday morning Mr. A. M. Hunt read a paper on "Emergency Generating Stations for Service in Connection With Hydro-Electric Transmission Plants Under Pacific Coast Conditions," as published in this number.

After a number of resolutions had been adopted and a cablegram of condolence regarding the death of King Edward sent to the British institution of Electrical Engineers, the meeting adjourned.

During the technical sessions the ladies accompanying the visiting members were entertained at various teas, theatre parties and sight-seeing trips.

On Thursday evening the visiting members were entertained by the local executive committee at a dinner at the Bohemian Club. On Friday evening a subscription banquet at the Poodle Dog was attended by about seventy members. Mr. S. J. McMeen presided as toastmaster in his usual brilliant fashion, calling in turn upon President Stillwell, Secretary Pope, W. W. Briggs, A. H. Babcock and A. M. Hunt.

On Saturday afternoon a large number visited Stanford University at the invitation of Professor Harris J. Ryan, who gave a lecture and experimental demonstration of his cathode ray power indicator, an instrument that produces diagrams of power present in high tension circuits, the corona volt meter, which indicates the maximum values of high alternating pressure and of the pressure surges, and the cathode ray indicator, which shows pressure and current wave forms in alternating current arc light and also the harmonics. The exhibition of these instruments excited great interest among those present, who felt amply repaid for the trip.

Many took the opportunity to visit the local power plants near the vicinity of San Francisco Bay while here, and on Sunday night a party of visiting members started on a trip of inspection over the lines of the Pacific Gas & Electric Company, the Great Western Power Company and the Northern Electric Railway Company, returning on Wednesday of this week. The list of those registered at the meeting is as follows:

Markham Cheever, Provo, Utah; H. T. Cory, Los Angeles; G. Faccioli, Pittsfield, Mass.; John B. Fisken, Spokane, Wash.; Victor H. Greisser, Spokane, Wash.; F. V. Henshaw, New York; Jno. Harisberger, Seattle, Wash.; Fred Hamilton, Visalia, Cal.; John Coffee Hays, Visalia, Cal.; Paul Lebenbaum, Portland, Ore.; H. W. Pudan, Carmel, Cal.; E. W. Paul, Upland, Cal.; Ralph W. Pope, New York City; W. E. Rundle, Orange, N. J.; Geo. I. Rhodes, New York; L. J. Scattergood, Pasadena, Cal.; Lewis B. Stillwell, Lakewood, N. J.; Frank R. Schalch, Chicago, Ill.; W. F. Wells, Brooklyn, N. Y.

Local—G. E. Anderson, Thos. Anderson, R. H. Atkinson, Wyatt H. Allen, C. F. Adams, R. M. Alvord, R. S. Buck, B. B. Beckett, F. L. Baer, C. W. Burkett, Orrion Brooks, Frank Barry, A. J. Bowie, Jr., Henry Bosch, J. P. Bradner, Geo. H. Bragg, A. H. Babcock, H. W. Crozier, B. C. Condit, C. L. Cory, P. O. Crawford, S. K. Colby, Clem A. Copeland, H. W. Clapp, S. B. Charles, Jr., W. F. Drake, W. J. Davis, Jr., R. Dolson, K. G. Dunn, W. A. Doble, P. M. Downing, J. G. De Remer, A. B. Domonoske, R. Deakin, F. Marion Edwards, E. G. Elliott, J. J. Ferrier, L. J. McFarland, H. P. Finnigan, Otto E. Falch, Jr., Donald H. Fry, S. G. Gassaway, R. H. Gerard, A. M. Griswold, C. F. Gilcrist, C. A. Gaines, C. W. Hutton Albert L. Harris, J. O. Hansen, H. M. Hall, H. Homberger, A. S. Heyward, C. S. Hall, W. W. Hanscom, John Hood, H. Y. Hall, A. M. Hunt, A. H. Halloran, S. W. Herr, W. A. Hillebrand, A. B. Johns, Louis F. Johnson, Geo. S. Johnson, Lars Jorgensen, J. P. Jollyman, Allen G. Jones, G. I. Kinney, Wm. R. Keyes, M. C. Lord, Thos. D. Lewis, H. A. Laidlaw, Douglas Lindsay, S. J. Lisberger, W. F. Lamme, F. V. T. Lee, C. A. Lozier, W. C. Myers, Wynne Meredith, G. R. Maxwell, F. E. Manzin, E. H. Mallory, W. C. Miller, Jr., Chas. K. Miller, Elam Miller, R. W. Mastick, Jr., George R. Murphy, S. G. McMeen, H. R. Noack, L. Nott, P. F. Orra, R. W. Pinger, R. Page, L. M. Perin, J. J. Pottinger, E. K. Preston, H. C. Parker, C. E. Rogers, L. Rehfuese, M. Rhine, C. E. Sedge-

wich, G. C. Robb, Harris J. Ryan, L. H. Somers, B. C. Shipman, R. E. Stevenson, F. H. Searight, F. O. Sievers, E. M. Sweitzer, E. O. Shreve, H. E. Shedd, Wm. G. Stearns, W. D. Scott, Geo. H. Scoville, Sidney Sprout, A. B. Saurman, L. E. Torrey, A. J. Theis, Frank T. Vanatta, Rudolph Van Norden, Max Vestat, W. G. Vincent, Jr., J. Wicks, C. J. Wilson, C. M. Weymann, C. A. Weymouth, Geo. C. White, Clarence Wortman, J. W. White, G. B. Wright, Henry N. Young, John F. Rhame.

PERSONALS.

A. M. Hunt is in Portland.

W. A. Purcell is now in the employ of the Great Western Power Company.

F. T. Robson, of Spalding, Sloan & Robson, engineers, is at Newman, Cal., supervising a hydraulic contract.

C. E. Johnson is now general manager of the United States Electric Manufacturing Company of Los Angeles, Cal.

Sidney M. Stone, of Hall, Demarest & Co., has returned to Virginia City, Nev., after visiting the San Francisco office.

A. C. Balch, general manager of the Pacific Light & Power Company of Los Angeles, was in San Francisco this week.

A. W. Vinson, engineer for the Cutler-Hammer Manufacturing Company's Pacific Coast office, is in Los Angeles on business.

Thomas Mirk, of Hunt, Mirk & Co., representing the Westinghouse Machine Company on the Pacific Coast, has been in San Diego.

C. A. Tupper, formerly publicity manager of the Allis-Chalmers Company, has opened an engineering-contracting office in San Francisco.

J. P. Bradner, until recently with the San Francisco office of the Fort Wayne Electric Works, is now with Pierson Roeding & Co. of San Francisco.

Paul Shoup, vice-president in charge of electric lines of the Southern Pacific Company, returned to San Francisco from Los Angeles during the past week.

John R. Freeman of Providence, Rhode Island, is at Vancouver, B. C., inspecting the site of the proposed dam of the Vancouver Power Company at Lake Coquitlam.

G. P. Jones, manager of the Western branch of the American Electric Fuse Company of Muskegon, Wis., is making an extended trip throughout the Northwest.

J. W. Hewitt has been appointed trainmaster of the Oregon Water Power Division of the Portland Railway, Light & Power Company, of Portland, to succeed S. P. Jones, resigned.

G. B. Shipley, chief engineer of the Allis-Chalmers Company's mining department, was in San Francisco during the past week. He is a native of California and was formerly connected with the Union Iron Works.

B. T. Longino, of the transportation department of the Seattle (Wash.) Electric Company, has been appointed assistant to Mr. F. A. Boutelle, superintendent of transportation of the Tacoma Railway & Power Company, Tacoma, Wash.

George R. Field, assistant manager of the Great Western Power Company, left last Monday for a trip to the company's power station at Big Bend, which was inspected during the week by a number of visiting electric engineers from Eastern and Pacific Coast cities.

L. H. Bean, manager of the Whatcom County Railway & Light Company, Bellingham, Washington, has been appointed manager of the Puget Sound Electric Railway, Pacific Traction Company and the Tacoma Railway & Power Company, Tacoma, to succeed W. S. Dimmock.

Henry W. Butler, resident engineer at Los Angeles, for J. G. White & Co., engineers, is visiting the company's San Francisco office this week. He has engineering supervision of the erection of two 12 000 kw. steam turbine generating sets for the Pacific Light & Power Company at Redondo.

Wynn Meredith of Sanderson & Porter's San Francisco office, returned last week from a trip to Vancouver Island, where his company is installing a power plant on the Jordan River for the British Columbia Electric Railway Company. Mr. Meredith was one of the electrical engineers who visited the Great Western Power Company's plant at Big Bend.

M. C. McKay, superintendent of the Stanislaus power station of the Sierra and San Francisco Power Company, has been in San Francisco in connection with starting up of the new Stanislaus transmission line. Mr. McKay is in charge of the operation of the power plant from the headwaters to the end of the 135-mile transmission line at San Francisco.

TRADE NOTES.

A. P. Eldred has been appointed Pacific Coast representative of the Brilliant Electric Company of Cleveland, Ohio, maintaining offices in the Monadnock building, San Francisco.

The Chicago Battery Company has been succeeded by the Vivax Storage Battery Company, 2228 Michigan Boulevard, Chicago, in the manufacture of the Duro line of storage batteries for automobile ignition and lighting.

The Los Angeles Gas & Electric Corporation has placed an order with Allis-Chalmers Company for three more 500 K. V. A. oil-filled, self-cooled transformers and three additional 500-kw. oil-filled water-cooled transformers.

The Cutler-Hammer Manufacturing Company of Milwaukee will hereafter manufacture and market for Kohler Brothers of Chicago in the United States and Canada, the various types of push-button operated controllers comprised in "The Kohler System" of control and its application to printing presses and other classes of motor-driven machinery.

Two Westinghouse low-pressure steam turbines, each having a capacity of 500 kw., have been added to the power plant of the Standard Steel Car Company at Burnham, Pa. These turbines utilize the waste steam of the main equipment, and are designed for a vacuum of 28 inches, which will be provided by Westinghouse-Leblanc condensers. The energy thus conserved is applied to two 500 kw. generators which furnish light and power for the shops.

The Pelton Water Wheel Company has an order from the Braden Copper Co. in Chili for turbine wheels aggregating about 13,000-hp. for a hydroelectric transmisison plant for their mines. There will be three 4000-h.p. Pelton-Francis turbines operating under a head of 420 feet at 600 r.p.m. Pelton oil pressure governors will be used. The contract includes also three exciter-turbines with fly wheels. Owing to the great amount of work in the San Francisco plant this contract will be fulfilled at the Pelton Water Wheel Company's eastern works.

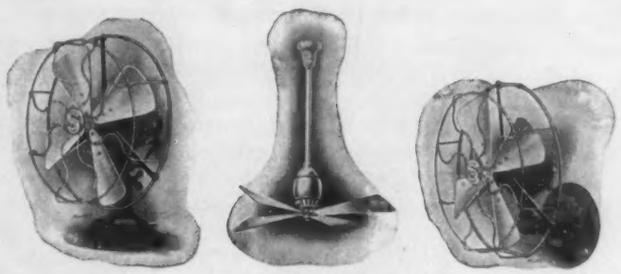
GAS-ELECTRIC MOTOR CARS.

Those connected with railway work will be interested in the attractive pamphlet recently issued by the General Electric Company, describing the single truck type of gas-electric motor car. The equipment consists of a direct coupled gas-engine and generator with an exciter on the same shaft, all completely inclosed and mounted between the axle of the truck and below the car floor, so that the interior of the car is entirely unobstructed. The operation is similar to that of an ordinary trolley car, and the car can be operated in either direction with equal facility. The car, motor, and engine are illustrated and described in Bulletin No. 4730, which contains also a table of schedule speeds for this car.

INDUSTRIAL

SPRAGUE ELECTRIC FANS FOR 1910.

There is every indication that the fan business this year will be unusually large and the dealers should be prepared to take advantage of an early demand. No time should be lost in getting catalogues and prices and in making contracts to insure prompt deliveries. The well known line of fans manufactured by the Sprague Electric Company is better than ever this season and also covers a wider range of types. The new types are the 8-inch hinge joint desk and bracket fans, the 8-inch telephone booth fans and the midget ceiling fans. The Midget ceiling fan has a sweep of blades of only 32 inches and can be used in many places where the full-sized ceiling fan would be out of place. It is also furnished in white enamel, including the blades, so that it is an extremely ornamental fan. Though on the market but a short time, many of them have been sold.



Sprague Electric Fans.

The desk and bracket fans this year have been improved by making the guard better and stronger. It is light and very durable. The standard or base of these fans have also been improved and simplified. It is no trick to change the non-oscillating universal joint fan into an oscillating fan.

The Sprague Electric Fans always have had a ready sale because of their excellence in design and construction. Dealers know that the Sprague Fans please the customers. The customer knows that if he has a Sprague Fan he can enjoy it without worrying about the current consumed or the possible need of repairs. Both items are reduced to the minimum. Sprague Fans displace a large amount of air, run quietly, require practically no attention and last indefinitely. Full description of these fans is contained in the 1910 catalogue No. 32154, a copy of which may be obtained by addressing such request to the Sprague Electric Company, New York City.

NEW CATALOGUES.

Booklet 5022, from the Fort Wayne Electric Works, lists various styles of a.c. and d.c. Fort Wayne Fan Motors for 1910, giving a brief description and price of each type.

Bulletin No. 389, from the National Brake & Electric Company, illustrates and describes various types of National emergency and variable release valves for use with the air brake operation of electric railways.

The high efficiency of the Mazda lamp makes it a competitor in the lighting of larger areas, and in order to equip it so as to meet these conditions most effectively, the Mazda Economy Diffuser has been designed. The special advantages of this diffuser are wide range of capacity, relatively low intrinsic brilliancy with excellent diffusion, and economical distribution of light. Bulletin No. 4729, recently issued by the General Electric Company, illustrates and describes the various designs of diffusers.

GRINDING AND BUFFING EQUIPMENTS.

The General Electric Company's new and improved types of alternating current buffing and grinding equipments are designed for use in wood working, machine and repair shops, foundries, large manufacturing establishments, etc., where alternating current is available. These devices find a ready application for dressing small castings, accomplishing the work much more quickly, and giving a finer finish than can be obtained with machine tool, chipping hammer, chisel, etc.

The grinding equipment consists of an alternating current motor with substantial supports fitted with tool rest and water attachment; these latter accessories being rigidly clamped to the bearing brackets in such manner as to permit ready removal when desired. Each end of the extended shaft is fitted with two steel flanges, two leather washers, and one nut for clamping the emery wheel securely in position. The motors are rendered splash and dust-proof by totally enclosing them; while shafts, bearings, attachments and all working parts are made extra strong and durable to withstand hard and constant usage.

The installation of a General Electric grinding equipment, where it is readily accessible to the shop force, enables the men to always keep tools sharp, thereby saving time, greatly increasing output and improving the quality of the finished product. As sharp tools require much less power to operate than dull ones, the cost of power may be sensibly diminished by keeping all cutting edges in the best condition. Workmen using dull tools are apt to become careless and eventually turn out inferior work, resulting, especially where competition is keen, in loss of the shop's prestige and patronage.

These self-contained, compact and rugged buffing equipments provide a very effective polishing device, the use of which invariably results in a great saving of time and labor. These devices are similar in construction to the grinding outfits with the exception that tool and water attachments are omitted. The shaft is also longer, each end being tapered and threaded for receiving the buffs. The bearing brackets are circular and so designed that they may be turned through 90 degrees to admit of side wall installation, thus allowing relocation of the device at will.

The following equipments may be supplied for operation on single, two or three phase, 110/220 volt circuits: Single phase, 3/8, 1, 2 and 3 h.p.; polyphase, 3/8, 1, 2, 3, 5 and 7½ h.p.

WESTINGHOUSE COMPANIES GET IRRIGATION ORDER.

The Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., has recently entered an order for two 600-kw. alternating current generators, to be installed in connection with the work of the Portales Irrigation Company, Portales, N. M. The Westinghouse Machine Company will make the gas engines to drive these and will also furnish three 500-hp. bituminous gas producers. The generators will develop a three-phase, 60-cycle, 2,300-volt current which will be stepped up to 11,000 volts. At the sub-stations this will be reduced to 440 volts.

In connection with this irrigation project, 72 motor-driven pumps will take water from wells, 30 to 50 ft. deep, and deliver it to the farms in the surrounding territory. Through their combined efforts many thousand acres will be made productive. The Western Construction Company of Wichita, Kans., has the contract for the construction work. It is expected that the cost of water per foot-acre supplied by the system will be sufficiently low to make it commercially practicable to reclaim hundreds of thousands of acres of similarly arid lands.

APPROVED ELECTRICAL DEVICES

ATTACHMENT PLUGS, FUSELESS.

Edison Type, 3 A. 250 V. Composition (weatherproof) Cat. No. 1151. Approved March 1, 1910. Manufactured by

C. S. Knowles, 7 Arch St., Boston, Mass.

CONDUIT BOXES.

"S. E. Co." For Rigid Conduit: Cast Iron, Cat. Nos. 2520, 2521, 2525 and 2526. Stamped Steel, Cat. Nos. 6200, 6200 straight electric, 6219-6222 incl., 6225, 622b deep, 6231, 6231 deep, 6249, 6250, 6300, 6350, 6350 deep, 6350 N, 6399, 6399 deep and 6400. For Flexible Steel Conduit or Steel Armored Conductors: Cat. Nos. 1904, 1905, 6236-6239 incl. and Cat. No. 6240 with fibre flange. Junction Boxes: Cast Iron, Cat. Nos. 2504-2514 incl., lined or unlined. Covers of stamped steel, cast iron or porcelain suited for above boxes. Approved March 4, 1910. Manufactured by

Sprague Electric Co., 527 W. 34th St., New York, N. Y.

"FA" Surface Receptacle Holders. Type for use as an outlet for FA Post Office floor or wall boxes. Type for use with rigid conduit. Approved only for exposed work March 4, 1910. Manufactured by

Frank Adam Electric Co., 904-914 Pine St., St. Louis, Mo.

CONDUIT BOXES, FLOOR OUTLET.

"Fountain" cast-iron floor boxes for use with rigid conduit; with brass cover plates and outlet nozzles. Cat. Nos. 250 and 260. Approved Feb. 28, 1910. Manufactured by

John Fountain, Jr., No. 28 Orange St., Newark, N. J.

CONDUIT OUTLET BUSHINGS AND COUPLINGS.

"Monitor." Galvanized steel bushings for rigid unlined conduit. Marking is B. "Erickson" insulated outlet bushings. Approved March 4 1910. Manufactured by

Bossert Electric Construction Co., Utica, N. Y.

GROUND CLAMPS.

"All-in-One" clamp for flexible or rigid conduit or for armored cable. Copper strap with clamps and bolts and having lugs into which connecting wires are to be soldered. "Vogel" clamp for signal systems only. A half-inch soft copper band heavily tinned, and brass clamping device. Approved Feb. 16, 1910. Manufactured by

Fairmount Electric Mfg. Co., 2320 Market St., Philadelphia, Pa.

LAMP GUARDS.

"Morse," Cat. No. 26, Portable Handle and Guard. Approved Feb. 28, 1910. Manufactured by

Frank W. Morse, 516 Atlantic Ave., Boston, Mass.

RECEPTACLES, STANDARD.

"G. E." Key and Keyless Types. Wall Sockets, Brass Shell. Key Cat. Nos. 9184, 27742, 28721 (slotted or closed base), 29404, 29406, 50753, (slotted or closed base) and 60018 also 88959 (for use on metal ceilings). Keyless Cat. Nos. 9185, 27743, 28722, 29405, 29407, 50755, 60019, and 60020, also 88960 (for use on metal ceilings). Porcelain Shell, keyless, 3 A., 250 V. Cleat Type, Cat. Nos. 11221, 28794, 28795, 50715, 59275 and 61039. Concealed Type,, Nos. 49355, 50717, 50744. Also 50752, fused, 2 A., 125 V. Moulding Types, Nos. 34152 and 42453. Conduit Box Nos. 9514. 9397, 40537, 49354, 60931 and 62357. Sign Receptacle, No. 46627. Approved March 1, 1910. Manufactured by

General Electric Co., Schenectady, N. Y.

"Paiste" Key and Keyless types. Wall Sockets, Brass shell. Key Cat. No. 9184. Keyless Cat. Nos. 9185 and 60019. Approved March 1, 1910. Manufactured by

H. T. Paiste Co., 32d and Arch Sts., Philadelphia, Pa.

RHEOSTATS.

"Allen-Bradley" Battery Charging Rheostat, Type H, 3000 watts, 110 Volts. Approved (for switchboard mounting only) February 26, 1910. Manufactured by

American Electric Fuse Co., Muskegon, Mich.

SWITCH BOXES.

"S. E. Co." For flexible steel conduit or steel armored conductors: Cast iron, Cat. Nos. 3001-3006 incl., lined or unlined, 5950, 5951, 5971-5978 incl., and 5991-5998 incl. Approved March 6, 1910. Manufactured by

Sprague Electric Co., 527 W. 34th St., New York, N. Y.

SWITCHES, KNIFE.

Type C, 30 A. 250 V. Single, double and four pole, and three-wire punched clip switches, mounted on slate bases. With or without N. E. Code standard cartridge enclosed fuse extensions. Approved February 25, 1910. Manufactured by

New Haven Electric Mfg. Co., North Haven, Conn.

SWITCHES, PENDANT SNAP.

"Perkins" 2 button types, single pole, 10 A. 125 V., 5 A. 250 V.; double pole, 10 A. 250 V. Single button types, 3-way, 5 A. 250 V., 10 A. 125 V. Electrolier and 4-point, 2 A. 250 V., 5 A. 125 V. Fan Motor Switches, 5 A. 250 V., 10 A. 125 V. Approved Feb. 16, 1910. Manufactured by

Perkins Electric Switch Mfg. Co., Bridgeport, Conn.

SOCKETS, MINIATURE.

Miniature and Candelabra Sockets, ½ A., 125 V. Pendant, Cat. Nos. 322 and 323. Brass Shell, Cat. Nos. 320 and 321. Candelabra Candle Socket, Cat. Nos. 328 and 347. Approved for use in connection with porcelain candle. Approved March 17, 1910. Manufactured by

The Bryant Electric Co., Bridgeport, Conn.

SOCKETS, WEATHERPROOF.

"Freeman" porcelain shell bracket keyless, 3 A., 250 V. Cat. Nos. 155, 156, for ⅛ in. or ¾ in. pipe. Approved (for use where not exposed to hard usage) March 15, 1910. Manufactured by

E. H. Freeman Electric Co., Trenton, N. J.

SWITCHES, SURFACE SNAP.

Diamond "H" Switches. Single pole, 5 A. 125 V.; 3 A. 250 V.; Cat. Nos. 220 and 2200. 10 A. 125 V.; 5 A. 250 V.; Cat. Nos. 221 and 2210. Double pole, 5 A. 250 V. Cat. Nos. 122 and 1220. 10 A. 250 V., Cat. Nos. 222 and 2220. 20 A. 250 V., Cat. Nos. 322 and 3220. 30 A. 250 V., Cat. Nos. 422 and 4220. Three-way, 5 A. 125 V.; 3 A. 250 V.; Cat. Nos. 123 and 1230. 10 A. 125 V; 5 A. 250 V.; Cat. Nos. 223 and 2230. Four-way, 3 A. 125 V.; 1 A. 250 V.; Cat. Nos. 124 and 1240. 5 A. 125 V.; 2 A. 250 V.; Cat. Nos. 224 and 2240. Electrolier, 3 A. 125 V.; 2 A. 250 V.; Cat. Nos. 125, 1250, 126, 1260. 5 A. 125V.; 2 A. 250 V.; Cat. Nos. 225, 2250, 226, 2260. Also above types with indicating dials or lock attachments, or both. Approved Feb. 9, 1910. Manufactured by

Hart Manufacturing Co., 103 Allyn St., Hartford, Conn.

WIRES, FLAME PROOF FOR SWITCHBOARDS.

Insulation consisting of an asbestos wind enclosed in two asbestos boards. Tag on coil to read, "Nat'l Elec. Code Standard." Approved, for use where not exposed to moisture as on switchboards, rheostats and similar apparatus subject to high temperatures and where the insulation will be subjected to a difference of potential of not over 600 volts, Feb. 16, 1910. Manufactured by

General Electric Company, Schenectady, N. Y.

NEWS NOTES

INCORPORATIONS.

VANCOUVER, WASH.—The Columbia Power & Light Company has been incorporated for $3,000,000 by Guy W. Talbot.

CALDWELL, IDA.—Articles of incorporation have been filed for the Caldwell Traction Company, for $250,000, by W. R. Sebree.

RICHMOND, ORE.—The Deschutes Mutual Telephone Company has been incorporated by C. R. McLallin, with principal office at Richmond.

CALDWELL, IDA.—Articles of incorporation have been filed for the Caldwell-Roswell-Big Bend Interurban Railway Company for $250,000, by W. P. Howard.

CONNELL, WASH.—The Connell & Kahlotus Telephone Company has been incorporated by Geo. F. Richardson, for $2,000, to build a line from this place to Kahlotus.

THOMPSON FALLS, MONT.—The Thompson Falls Light & Power Company has been incorporated for $30,000 by Edward Donlan, to develop power from Prospect Creek.

NELSON, B. C.—The International Electric Company has filed articles of incorporation for $1,000,000, ostensibly for the electrification of the Crows Nest Pass route of the C. P. R.

WALLA WALLA, WASH.—The Walla Walla Railway Company has been incorporated for $500,000 by Lewis A. McArthur, to build an electric railway from Walla Walla to Milton, Ore.

EVERETT, WASH.—Moses Lake Land Company has been incorporated for operating street railways, etc., also for doing general contracting business, by Daniel Duryea and Schuyler Duryea, for $1,000.

PORTLAND, ORE.—The Tri-State Railway & Power Company has been incorporated by W. D. Riddell, R. B. Mandage and T. M. Peters, with a capital stock of $10,000. The principal office of the company in Portland.

PORTLAND, ORE.—The Rogue River Irrigation & Power Company has been incorporated by P. Williams, A. M. Crawford and W. B. Sherman, with a capital stock of $1,000,000. The principal office of the company is in Portland

TRANSMISSION.

LONG BEACH CAL.—Surveyors have been employed by the Southern California Edison Company, for the purpose of laying out a line for the building of the first unit of the $6,000,000 power plant here.

REDDING, CAL.—The Northern California Power Company has acquired the 209 acres of land near Whitmore it needed to complete its 1,540-acre reservoir site. This is the tract of land for which Daniel F. Covey sued his son and daughter, asking the court to annul a deed of gift he had made to them in 1902. The Court annulled the deed. The power company brought suit to condemn this land. Daniel F. Covey and the company agreed outside of court on terms of sale.

SAN FRANCISCO—Sanderson & Porter report that the Stanislaus transmission line from the station near Angels' Camp to San Francisco, 135.1 miles long, was tested out on on May 7th to 110,000 volts. The regular operating pressure is to be 104,000 volts. At present a very careful inspection of the line is being made for mechanical defects and upon its completion the line will be put into operation transmitting power from the Stanislaus power station to the Bay Shore substation in the Visitacion Valley and thence to the various substations of the United Railroads, which are now being fitted with 1500-kw. synchronous motor generator sets. The main transmission line is Y connected at both the power house and the substation and the distribution to the United Railroads at 12,000 volts delta connected. A motor generator set in one of the United Railroads' substations has been actually operated from the Stanislaus plant. A Bowie high tension switch is being installed near the Bay Shore substation as an emergency protection. The disconnecting switches for outdoor use are being manufactured by the Pacific Electric Manufacturing Co. in San Francisco.

SPOKANE, WASH.—Official confirmation has been received in Spokane of the reported sale of the Northwestern Corporation to the Columbia Power and Light company, recently incorporated under the laws of Idaho, and the Byllesby Company of Chicago, the transaction involving more than $3,000,000. The transfer includes gas plants, franchises and contracts at Walla Walla, Pendleton, Oregon and North Yakima, and electric light systems and franchises at Dallas, Independence, Monmouth, Albany, Corvallis, Eugene and Springfield, Oregon, together with the gas plant at Eugene and water works at Independence, Albany and Springfield. The Byllesby Company, which recently obtained control of the gas and power plants at Olympia, Tacoma and Sandpoint, Idaho, takes over the Coos Bay gas and electric plants and the street railway and the Condor Light and Power Company, held under option by the Northwestern Corporation. The latter company furnishes light and power for Ashland, Medford, Grants Pass, Jacksonville and several smaller towns in Southern Oregon. The Columbia Light and Power Company has also purchased from Robert E. Strahorn of Spokane, president of the North Coast Railway, the Northwest Light and Power system at North Yakima, which serve Mabton, Toppenish, Sunnyside, Prosser, Kennewick and Pasco, and furnishes power for the irrigation districts adjacent to the towns. It is given out that the high tension line will be extended from Pasco into Walla Walla. From Walla Walla comes the announcement that the holdings of the Northwestern Corporation, recently taken over by the American Power and Light Company, will be transferred to the Columbia Co.

ILLUMINATION.

OLYMPIA, WASH.—A. E. Wright of Olympia has been garnted a franchise for a gas plant, the pipes in the business section to be laid within four months.

SAN BERNARDINO, CAL.—A new light plant is to be constructed at the Olinda oil fields of Santa Fe. It will be commenced within a few days and cost $10,000.

OAKLAND, CAL.—The Central Oakland Light and Power company has just built a modern steel frame power station near the water front in Oakland, and the plant will be completed this summer.

GUADALAJARA, MEX.—Geo. H. Eckert of San Francisco and W. A. Aldrich of Grand Rapids, Mich., gas engineers, have arrived here to take charge of the work of installing a gas plant and distributing system for the Gas Operating and Construction Company of Los Angeles organized to operate under a concession secured from the state government by J. Guillermo Dominguez. W. S. Morse, head of Morse Lumber Company of Los Angeles, is the president of the company.

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